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ON CIRCULATION AND COMMUNICATION IN RAILWAY TRAINS.

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It is only within the last few years that science has rendered it practicable, and the development of traffic profitable, to convey passengers between certain places for two hours continuously at an average speed of forty-five miles an hour. We have, however, arrived at that stage of progress. Trains run daily between London and Dover, by the South-Eastern Railway, a distance of 88 miles, in 1 hour and 55 minutes; from Chester to Holyhead, 84 miles, in 2 hours and 7 minutes; from London to Rugby, 82½ miles, in 1 hour and 50 minutes; from London to Swindon, 77½ miles, in an hour and a-half; and from London to Peterborough, 76¼ miles, in 1 hour and 37 minutes. We may also go any evening from London to Manchester, 196¾ miles, in 5 hours; or any day from London to Edinburgh, 399½ miles, in 10 hours and 30 minutes; or from London to Inverness, 604½ miles, in 18 hours and 5 minutes. We undoubtedly perform these and other journeys in a most luxurious manner as compared with the road travelling of former days, or of the present day. First-class passengers sit on soft cushions, second-class passengers sometimes on harder ones, and third-class passengers are almost always provided with seats and sheltered from the weather. But there are inconveniences still to be overcome, and many improvements to be effected. Fixed periods of stoppage at suitable intervals, or a few minutes extra at certain stopping stations would, with the present arrangements, be a great boon to ladies and children, to the weakly and the infirm. The refreshments to be obtained at most of the stations are a disgrace to the country. Better means of sleeping might easily be afforded on long night journeys. The insertion of a little vulcanized india-rubber between the bodies and the framing of the carriages would render talking less laborious, reading less difficult, and writing quite possible, in day journeys. Many broken legs and severe contusions would be avoided if pads were more commonly added to the edges of the seats in second and third class carriages; and life and limb are often sacrificed when stronger carriages, with a greater proportion of break-power in the trains, would save them. The carriage lamps, from being ill-constructed, out of repair, or badly trimmed, often burn dimly or go out altogether. Improvements in the construction and maintenance of the permanent way and the rolling-stock; locking apparatus at junctions, which render it impossible for the signalman to make such a mistake in working his points and signals as shall lead to a collision; safety tyres, which cannot fly from the wheels or cause an accident when fracture occurs,—have been, or are being, less rapidly adopted than might be expected from the great advantages that they afford. And we are still, in this year of grace 1865, without any means of circulation or of passenger communication in the trains.

A two hours' run without a stoppage is, when all goes smoothly, a charming mode of passing over eighty or ninety miles of ground; and a private compartment for the journey is convenient for a family, pleasant for a bride and bridegroom, and may be suitable to the desire for seclusion which is supposed to be inherent in the English character. The cellular principle, also, has unfortunately grown up with the railway system, and become a fixed institution, with the usual hold on certain prejudices. By means of two doors to each compartment the readiest means of ingress and egress are afforded on either side at the stations, or, when the doors are unlocked, in cases of emergency. But the means of retirement for necessary purposes, or of obtaining refreshments on the journey, are wanting; and when a carriage becomes disabled, or when a lunatic, a drunkard, or a villain forms one of the party, or even when a nervous traveller is left alone with one of the opposite sex, the pleasure of the journey becomes changed into discomfort, terror, danger, or worse. The advantages of separate compartments and isolated carriages are principally on the side of the railway companies, while the comparative privacy is dearly purchased by the passengers; and there is no doubt that the strong feelings which have been lately expressed are only lying dormant until some new case, attended by startling results, calls them forth again, and brings public attention and public discussion once more to bear upon the subject.

As it frequently happens, the case in connection with which the necessity for passenger communication has been most prominently insisted upon, is not only not the strongest that can be urged, but is really not an instance at all in which such communication would have been useful. Mr. Briggs was evidently stunned at once by an unexpected blow. His murder, robbery, and ejection from the carriage, and the escape of the murderer, were all completed within so short a time as to negative the idea of resistance, or opportunity for the employment of any means of communication that might have been at his disposal. Mr. Briggs was travelling, too, on a line on which the stations were unusually frequent, and by a train which was due to stop every few minutes. Just as it is impossible to prevent a man from striking or even garotting another in the street, or from shooting from behind a hedge, if he be so minded, and if his intentions be not known, so also no facility for communication which could practically be afforded would provide against a sudden attack by one railway passenger upon an unsuspecting and perhaps sleeping *vis-à-vis*; and it would further be difficult to provide for the stoppage of a train, upon a signal of distress being given, more rapidly than this particular train was actually stopped in its ordinary course after the murder. It is a question whether even the deterrent influence of a ready means of communication, which would be very powerful to prevent outrage in many cases, would have had any effect on so daring and determined a villain as Müller. On the other hand, it was the certainty of isolation for a sufficient, though a very short period, that made Müller's project feasible, and his escape comparatively easy; while, if there had been free circulation through the train, with publicity or supervision in the interior of the carriages, he would not have contemplated the commission of such a deed.

But murder, and other deeds of lust or violence, have a command of newspaper space, and therefore, we must suppose, a morbid interest for the public, which is out of proportion to their real significance; and it is not surprising that the murder of Mr. Briggs should have been seized upon to illustrate a real want, which was much and deeply felt, in preference to other and more apposite instances. Passenger communication is more required in cases of accidents to trains, and circulation to prevent offences against individuals. But the circumstances of railway accidents are not, excepting where death ensues, brought to light before any public tribunal; and the official reports in which they are detailed are only presented to Parliament after they have lost their interest for the general public. All serious offences, on the other hand, become immediately the subject of judicial investigation. The evidence in connection with them is placed fully before the public, and they are more readily described and understood.

The most alarming cases of accidents to trains that have happened from time to time, are those in which disabled carriages, or carriages on fire, have been dragged along at high speed for considerable distances, while passengers or their luggage were left behind on the line, without the servants of the company being aware that anything was wrong. And of the numerous offences that have been reported within the last year or two, one of the most striking, perhaps, if not the most important as regards our present subject, was that in which a female passenger was driven by the fear of insult or assault to jump out of the carriage in which she was riding, and to hold on to the outside of a train in motion, at the imminent risk of her life. Space will not admit of the enumeration of many cases, but we may give an outline of two accidents, on which reports were presented to Parliament in June last,* and which are quite sufficient to show the risk incurred.

On the 21st March last, Sir Charles Fox was travelling with a brother engineer on the Great Western Railway, by the South Wales train which joins the 12.50 A.M. express from Bristol to London at Swindon, when he was awoke at ½ past 3 o'clock in the morning, near Goring, by the fracture of the tyre of a wheel over which he was sitting. The passengers in the other compartments of the carriage shouted with him in chorus, but in vain. One of the guards who rode in the carriage next behind the tender, knew nothing of what had happened until he afterwards heard the break-whistle from the engine; but a second guard, in the fifth carriage, and a third guard in the seventh and last carriage, both felt a shock in running over something which fell upon the rails; and they endeavoured in vain to attract the attention of the engine-driver, by their hand-lamps, and by suddenly applying and releasing their breaks, without themselves hearing the shouting of the passengers. The engine-driver thought the train went a little heavily through the Pangbourne cutting, but he attributed it to the wind, which was strong, and he advanced his reversing lever "another notch." Looking round afterwards to see why his train was so heavy, he observed nothing wrong with it, and was only induced to pull up by the red light of one of the guards. But the train ran upwards of six miles and a quarter before it was brought to a stand, and even then it was a mere chance that the engine-driver's attention was obtained. The passengers were quite powerless, and the guards themselves were making signals without result for a considerable period, during which much risk was incurred.

On the 24th of the same month, Mr. William Baker, the Engineer-in-Chief of the London and North-Western Railway, was travelling from Leamington to London, by the 7.25 P.M. train from Birmingham, on the same railway. The train was composed, on leaving Reading, of an engine and tender, a break-van, a composite carriage, a first-class carriage, and a third-class (break) carriage. Mr. Baker sat with Mrs. Baker, and Mr. Berkeley, a Fellow of Trinity College, Oxford, in a first-class compartment, second of five, in the composite carriage behind the leading van, while Mr. Ransford, of Chancery Lane, was travelling with three other passengers in the last compartment. Soon after they left Reading, and a little before 10 P.M., one of the axles gave way, and the carriage began to jump violently. The passengers, much alarmed, waved hats, rugs, coats, and handkerchiefs, swung the door backwards and forwards, shouted, and did all they could to attract attention; and Mr. Ransford even shook his handkerchief, as he expressed it, frantically in a signalman's face; but neither the engine-driver, nor the guards, of whom there were two, nor the signalmen, of whom there were a considerable number, perceived anything wrong with the train, until the carriage left the rails on a curve at the entrance to the Paddington Station, and ran with some violence against the edge of the arrival platform. In making signals to attract attention, Mr. Baker and Mr. Ransford struck their hands against an obstruction at the side of the line, which turned out afterwards to be a signal-post, and received severe contusions, the former breaking a bone in his arm, and the latter his thumb. The train was a short one, with a guard at each end of it, but it travelled for about thirty-four miles at fifty or sixty miles an hour after the fracture of the axle, without the servants of the company having an idea that anything was wrong. It appears that the passengers were shouting or making signals from the near side, while the guards looked out from and the switchmen were most of them standing on the off-side. The feelings of the passengers may be best described in the words of Mr. Baker :— "We thus had upwards of half-an-hour of awful suspense, during which time we expected every moment to be dashed to pieces; and I may add, that I most seriously regretted the absence of any means of communication with the guard, so that he might stop the train and release us from our perilous position."

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* Accidents on Railways, January to April, part ii., 1865.

A passenger so situated is nothing more nor less than a modern Mazeppa,—quite as helpless, though his limbs be free,—riding farther and faster, though on a more level route,—and just as liable to be "dashed to pieces," though under a carriage roof,—as his ancient prototype; the only difference between them being that the wild horse was only supposed to carry one, while the steam-horse will accommodate any number of victims.

Our neighbours on the Continent are not without similar troubles, as will be seen by the following account, which is one of several, by the Baron de Janzé,* of an accident which occurred on the route from this country to Paris, in the *same month* of the present year, as the two cases related above :—" Le 1er mars dernier, sur la ligne du Nord, et non loin de la station de Boves, un bandage de roue de l'avant-dernière voiture d'un train se brise : les deux roues de derrière quittent les rails, et 500 mètres plus loin, arrachées au wagon auquel elles appartenaient, elles sont jetées sous la dernière voiture, qui déraille, ainsi que le fourgon placé derrière elle. Plusieurs voyageurs sont blessés ou contusionnés, et l'un d'eux, qui avait le bras cassé, est retirée, à l'aide de cordes, par la portière de la voiture renversée sur le coté.

"Le mécanicien continue sa route sans se douter qu'il a perdu un wagon et un fourgon, sans s'apercevoir que la voiture qui a perdu ses deux roues de derrière est traînée sur ses ressorts avec d'horribles secousses, et court à chaque instant risque d'être renversée. Ce n'est que *trois kilomètres plus loin* qu'il s'arrête et constate que, *par bonheur*, cette dernière voiture ne contient pas de voyageurs."

The French have had their murders also, of Heppi and Poinsot, and the young Englishman whose corpse was found near the Villefranche station, on the Mediterranean line, at 5 A.M. on the 30th April, 1864, to set against that of Mr. Briggs; and M. Poinsot's murderer appears to have obtained access to the compartment in which his victim was riding, as well as to have escaped from it, along the footboards. The following, also related by the Baron de Janzé, is, on the other hand, a singular instance of the advantage of being able to use the footboards in the absence of a better means of circulation :—"Il y a quelques jours (16 août, 1863), au moment où le train-poste, arrivé à Evreux à 11 heures du soir, allait repartir, un individu d'assez mauvaise tournure était monté dans un compartiment de première classe où se trouvait une jeune dame avec un autre voyageur. Le train venait à peine de se remettre en marche, lorsque l'intrus, s'approchant de la dame, voulut se porter sur elle à des actes de violence, malgré l'intervention du tiers, témoin de cette scène et trop faible pour l'empêcher d'accomplir son odieux dessein.

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* Accidents de Chemins de Fer, par J. Bisson, publiés et annotés par le Baron de Janzé, Député, Paris, 1865.

"Fort heureusement, les cris poussés par la victime de cette odieuse tentative, et par son défenseur, furent entendus des voyageurs qui se trouvaient dans le wagon voisin. Le sieur Roussel ouvrit la portière, et vint, en longeant les marchepieds, jusqu'au compartiment où la dame, presque à bout de forces, luttait contre son agresseur. Y pénétrant aussitôt, ce libérateur, qui paraît doué d'une énergie et d'une force peu communes, parvint, non sans peine, à terrasser le quidam, cause de ce scandale. Aidé du monsieur et de la dame, il lui attacha les pieds et les mains avec des mouchoirs, et c'est dans cet état que le coupable a été amené à Conches et remis entre les mains de la gendarmerie."

These instances of the dangers of isolation, must, however, suffice, and we will next proceed to consider how they can best be avoided.

In America they do not exist, simply because there is free circulation through all the carriages of a train. Publicity and the means of escape are thus both afforded as safeguards against offence, and a cord running under the roof throughout each train, provides a ready means of giving warning to the engine-driver in case of accident.

In Switzerland and parts of Germany, the same system of circulation through the carriages is in force, and without some of the disadvantages experienced in America, inasmuch as the carriages are separated into compartments of different classes, and the doors between them will open freely, for instance, from the 1st to the 2nd, but not without a key from the 2nd to the 1st class. The *conducteur* is thus in frequent communication with the passengers, he sees their tickets while the train is in progress, and he has them all, as it were, under his eye.

In Belgium generally, and in France partially, as any one may see who travels to Paris by the Chemin-de-fer du Nord, the want of internal, has led to the adoption of external circulation, though not without risk and loss of life. It was calculated in 1860, that one *contrôleur* lost his life every year in Belgium by accident in perambulating the footsteps, besides those who were injured; and as there are ten times as many miles now open in this country as were at that time open in Belgium, we should probably, if we attempted to carry out the same system, lose ten guards a year killed, and others injured.

But there are other reasons why it would be impossible, without extensive alterations, to carry out such a system generally on British railways. The ordinary width of the carriages is 7′ 4″, projecting 1′ 2″, and they are constructed on many lines up to widths of 8 or even 9 feet, projecting 1′ 6″ or 2′ on each side of the rail. The distance between the two lines of rails is 4′ 8½″ or 5 feet on some of the older lines, and 6 feet on modern lines; and the maximum distance between the rails and the side-works varies on different lines. To take an instance, the minimum distance between the outer rails and the side-walls on the London and North-Western Railway is in the following tunnels:—

	Up side.		Down side.	
	Ft.	In.	Ft.	In.
Beechwood Tunnel (near Coventry) . . .	2	3	2	3½
Walford Tunnel	2	3	3	4½
Primrose Hill Tunnel	2	8	2	5

But allowing 2′ 4″ in the clear as the minimum space in which a conductor should be allowed to pass between the outside of a carriage and a standing work at the side of the line, there would then be required, for a carriage 7′ 4″ wide, 3′ 6″; for one 8′ wide, 3′ 10″; and for one 9 feet wide, 4′ 4″, between the outer rail and such standing work. And the dimensions above given are, as will be seen, quite insufficient to provide such spaces, there being only nine inches between the up sides of the two former tunnels and those of a carriage 8 feet wide, and only 1′ 3″ in the case of a carriage 7′ 4″ wide, to allow of the passage of a guard.

The Regulations of the Railway Clearing House contain a very good guide to the minimum dimensions of the works, in the table showing the *maximum dimensions* of a *carriage* or *wagon load* which will travel safely over the different lines in the country. It will be useful here to extract the particulars for a few of the principal Railways:—

	Width of Load.		Height in Centre.		Height at Side.	
	Ft.	In.	Ft.	In.	Ft.	In.
Caledonian and Branches	10	0	14	0	10	9
Except Portpatrick	9	0	12	11	10	9
Great Northern and Branches	9	3	13	9	10	3
Great Western:—						
Broad Gauge	11	6	15	0	11	8
Narrow or Mixed Gauge	9	2	15	0	11	8
Birkenhead	8	9	12	9	12	0
Coleford, Monmouth, Usk and Pontypool . .	8	6	13	0	11	0
Leominster and Kingston						
Much Wenlock and Severn Junction . . .	9	0	13	0	11	6
Newport, Abergavenny and Hereford . . .	9	0	13	0	11	0
Oxford, Worcester and Wolverhampton . . .	9	0	13	0	11	6
Severn Valley						
Shrewsbury and Birmingham	7	8	13	4	11	8
Shrewsbury and Chester						
Shrewsbury and Hereford	9	0	13	0	11	6

	Width of Load.		Height in Centre.		Height at Side.	
	Ft.	In.	Ft.	In.	Ft.	In.
Great Western (*continued*):—						
South Wales	10	6	15	0	13	0
Stourbridge Tenbury Tenbury and Bewdley Witney	9	0	13	0	11	6
Worcester and Hereford	8	6	13	0	11	6
London and North-Western:—						
Main Line and Branches	9	0	13	3	10	7
Wapping Tunnel, Liverpool	8	10	12	2	8	0
Waterloo Tunnel, Liverpool	9	0	13	3	10	7
Chester and Holyhead	9	0	13	11	13	9½
Knighton	9	0	14	0	12	0
Lancaster and Carlisle	8	3	13	3	11	4
Shropshire Union (except Coalport Branch)	9	0	13	6	11	5
Ditto Coalport Branch	9	13	13	6	10	10
South Staffordshire	8	9	13	0	12	0
St. George's Harbour	8	3	13	3	11	4
St. Helen's	9	0	12	0	11	0
Warrington and Stockport	9	0	13	6	10	8
North British and Branches (except as under)	8	0	12	0	11	0
Burntisland to Perth Dundee and all Branches	9	0	13	6	10	4
St. Andrew's	9	0	12	2	10	4
Bridge at bottom of Pittencrief incline	9	0	8	9	7	6
Border Counties Border Union	8	0	12	0	11	0
Carlisle and Silloth Bay Port Carlisle	9	0	13	6	13	0
North-Eastern (except as under)	9	0	13	6	11	0
Marsh Lane (Leeds) Station	8	0	13	6	11	0
Newcastle and Carlisle Section	8	6	15	0	10	6
Stockton and Darlington Section	8	4	13	6	11	6
Scottish Central and Branches	8	8	13	8	11	2

This subject has also been investigated in France. The Commissioners who were appointed after the murder of M. Poinsot to report upon the security of passengers in railway trains, state in their report of the 12th April, 1861:—"Le contrôle de route, il faut le reconnaître, sera, quoi qu'on fasse, toujours accompagné d'un certain péril. Le prescrire d'une manière absolu sur toutes les lignes et en tous les points, ce serait pour l'administration assumer la responsabilité de graves accidents et jouer un rôle fâcheux auprès des agents des compagnies. Indépendamment de cette considération, nous avons vu que, dans un grand nombre d'ouvrages, il faudrait élargir l'accotement en rétrécissant l'entrevoie, mais que ce rétrécissement ne pouvait dépasser certaines limites."

The carriages in France vary in width from 8′ 6″ to 8′ 8″, and the intermediate space between the rails and the side-works is 4′ 2½″ in the majority of cases, though sometimes less. The French Commissioners considered that the width of a door, or 2 feet in the clear, would be sufficient for the passage of a *contrôleur;* and they come to the following conclusions:—

"1. Le contrôle de route est partout impossible du côté de l'entrevoie.

"2. Le contrôle de route n'est possible sur l'accotement qu'avec une distance de 1m. 30 (4 ft. 3 in.) entre l'axe du rail extérieur et les parois d'ouvrages et objets de toute nature placés sur le flanc de la voie. Cette distance de 1m. 30 peut d'ailleurs n'être considérée qu'à 1m. 20 au-dessus du rail (hauteur de l'arête inférieure d'une portière ouverte); mais elle doit en revanche régner encore à 2m. 70 (hauteur de l'arête supérieure de la dite portière) au dessus de ce même rail."

And they recommend that "Les compagnies devraient organiser sur toutes les voitures composant les trains de voyageurs un système de marchepieds et de mains courantes horizontales, qui permette, soit aux agents mêmes du train, soit à des contrôleurs spéciaux, de parcourir toute la longeur du convoi du côté des accotements du chemin. Les mains courantes pourront être interrompues devant les portières; mais elles deborderont, ainsi que les marchepieds, les deux extrémités de la voiture à 25 centimètres au moins de largeur."

The general commission on French railways, which was appointed on the 5th November, 1861, and reported in 1863, stated their own conclusions as follows:—

"3. Que toutes les fois que la composition des trains ne s'y opposera pas, la communication entre les gardes freins et le mécanicien devra être rendue obligatoire; qu'il n'y a pas lieu de faire de même, en ce qui touche la communication entre les voyageurs et les agents du train."

This question of circulation in trains has, indeed, formed a constant subject of invention and discussion for many years. The Commissioners of Railways issued a circular in October, 1851, pointing out how desirable it was that "the power of travelling along trains whilst in motion should be given to the guards and servants of the Company;" and several of the English Companies having expressed their willingness to adopt the Belgian arrangement, the consent of the Post Master General was obtained to the addition of steps to the post-office vehicles, with a view to its being generally carried out. In 1852 a sub-committee was appointed by a minute of General Managers at the Clearing House, to consider a proposal from the Board of Trade to use the footboards of the carriages as a means of communication on the outside of trains. This sub-committee drew up a list of queries, and circulated them amongst all the railway companies in the kingdom. They received replies from thirty-five companies, from which it appeared, that there were twenty-three companies on whose lines either bridges, tunnels, or other permanent structures rendered it dangerous to pass along the side of a train in motion; there were sixteen companies whose station-platforms would have required alteration if the footboards of the carriages had been lengthened; and all these companies were in the habit of running cattle-trucks or goods-trucks to a greater or less extent with their passenger-trains. All but two stated that no accident had occurred which might have been thus prevented, and that they considered the power of passing along the footboards would lead to rash exposure on the part of the public. All but five thought that if passengers were able to move from a lower to a higher class of carriage, they would be likely to take advantage of this means of defrauding the companies. All but one thought the system would afford facilities for robbery and assault upon passengers, and especially on females travelling alone. Four companies had employed the system for general purposes, and two especially for the collection of tickets, but one had discontinued it from apprehension of danger, and another after an accident; and a third did not consider that it had been attended with benefit or the reverse. All but three thought that the disadvantages of its adoption would preponderate.

The sub-committee came finally to the conclusion,—

"That there are several railways, the dimensions of whose permanent structures would prevent the plan from being generally adopted, without which it would be inoperative; that the expense of the alteration (which they estimated at 165,855*l.*) would be out of all proportion to the benefit that would be derived from it, that it would expose the public to great danger and to robbery, and the companies to fraud; and that, therefore, it is not desirable to adopt it."

The above apprehensions as to damage to the public were actually realized by the murder of M. Poinsot already referred to; and the difficulties of external communication have since increased, and continue to increase, in consequence of the carriages being frequently constructed of extra width.

It is, indeed, evident, that alterations so extensive as to be hardly practicable, would be required in the rolling stock and works on many of the railways, including most of the through lines, in order to provide at the present time for external circulation. And if the necessary alterations were made, by widening the works and lessening the width of the carriages, by adding convenient handrails and footsteps to all the vehicles used in passenger-trains; and, perhaps, by covering this outside gallery with a framing of bars or network, as has been frequently proposed, the resulting system would still remain open to the serious objections which have already been partially referred to; and the more secure the means of circulation the greater, in one respect, would be the disadvantages attending it. It would be impossible to confine the use of the footboards, or of an outside gallery, exclusively to the servants of the company. Complaints would be made of strange passengers finding entrance to the carriages after the starting of the trains, similar to, but more frequently than, those which have already appeared of their crawling from under the seats. External circulation has not the advantage of publicity, which in the case of internal circulation exercises so wholesome a check on certain passengers, as well as on the servants of the company. Card-sharpers and others travelling for plunder, would find the former convenient, if they happened to start in a compartment ill-suited to their purposes; and, in fact, they would be enabled to visit different carriages, while the train was in motion, in search of prey; or it would, at all events, require several guards in a long train, always on the look-out, to prevent them from doing so. Neither male nor female passengers would go to sleep with the same degree of confidence in the "limited mails" or other night trains, if they were liable to receive unwelcome visitors of any class, without supervision, at all parts of the journey.

It would appear, therefore, that as a general rule external circulation is in this country neither practicable nor desirable, and that it would be particularly unsuited to those long journeys on which protection is most required. But it is quite otherwise with internal circulation, which, on the other hand, would afford many advantages. The American system could not, of course, be adopted without modification. The sub-committee of the Clearing House which reported on the 9th March, 1853, stated on this point:—"23. And as regards the American arrangement, it is obvious that it is so opposed to the social habits of the English, and would interfere so much with the privacy and comfort which they now enjoy, that these considerations, apart from others nearly as important, would forbid its adoption in this country." And the sub-committee which reported on the 25th of March last, state,—"11. As to the suggestion that the English companies should adopt carriages built upon the American plan, which allows of internal communication from one part of the train to the other by means of a central passage, the sub-committee is satisfied that the habits of English travellers would not tolerate any such system. Apart from the enormous outlay which would be involved in a reconstruction of the stock of the different companies to secure a doubtful advantage, the delays which would arise in the loading and unloading of trains on the great railways of England, particularly in the metropolis and at other great centres of population, would be productive of very serious evils. Any person who has travelled upon railways where these carriages are in use must have observed the great loss of time which is consequent upon the means of leaving and entering them being limited to the doorway at each end, instead of taking place by the more numerous doorways parallel to the platform, as in the ordinary English carriages."

But the second sub-committee seem to go too far in saying that the "habits of English travellers would not tolerate *any* such system." The fact is that neither English nor any other travellers have much choice in railway travelling. Their habits are to a great extent formed for them. They are compelled to avail themselves of the conveyances provided by the railway companies, and are frequently obliged to tolerate that which they would not willingly put up with. The British passenger is only exceeded in patience and forbearance by the railway shareholder, and we make bold to say that both would be quite disposed to acquiesce in any system that may be proved upon full consideration to be the best for his own and the general good. There is no good reason why a means of passing through the trains should not be combined with the separation of classes, and even compartments, by sliding doorways, as well as with a certain number of side doors for facilitating ingress and egress, so as to avoid extra delay to any serious extent at the stations. The Swiss carriages, for instance, have all the advantages of internal circulation, without the drawbacks of the American cars; and, indeed, carriages to fulfil this condition may easily be constructed in great variety of dimensions, fittings, and doorways, so as to be suited to every description of traffic on different lines in this country. The only real disadvantage—to which the sub-committee have not referred—would be as regards the old carriages, that the number of passengers that could be conveyed with equal comfort, or in proportion to dead weight in each vehicle, would be somewhat diminished. But little or no loss in these respects need occur in carriages specially constructed.

It would certainly take time, and be an expensive process, to re-arrange the internal fittings of the carriages now in use; and the system would be imperfect as long as any carriage with separate compartments were allowed to run. But, looking to the requirements of future years, in the course of which the traffic of the country will, we hope, increase at least as heretofore,—still longer journeys will more frequently be performed without stopping,—and passengers will be furnished at moderate charges with all that they require in the trains, and will not be obliged to leave them during a journey,—it would appear that the system of internal circulation, now much required, will eventually become indispensable. And this remedy is, therefore, one which should be kept in view, and for which preparation should be made, not only for the good of our own, but still more for the sake of the next generation. It would be no hardship on railway companies, but for their future good, and the best method of attaining this object, if it were to be provided by legislative enactment that no passenger carriages should hereafter be constructed for railway purposes without the means of internal circulation, and that all existing carriages should be so far altered within a certain number of years as to fulfil the same conditions. We should then, within say five or ten years, have a complete means of internal circulation in all passenger trains; and the more the subject is considered, the more it becomes evident that this is a most important, if not the principal, desideratum.

In the meantime, as a means of partial publicity, glass has been inserted experimentally in different shapes—either fixed, or to open and shut—in the partitions of some of the carriages on several lines. The French Commissioners who reported in 1861 were, for want of a better, much in favour of this expedient. They stated:—"La glace dormante placée à la partie supérieure des cloisons offre, sur une moindre échelle, quelques-uns des avantages de la communication entre compartiments. Elle peut, dans certains cas, être d'un utile secours aux voyageurs, inspirer une crainte salutaire aux mals intentionnés, et constituer, en tout cas, un épouvantail matériel ou moral. Elle ne porte aucune atteinte ni à la commodité, ni à l'indépendance des voyageurs, qui seront toujours à même d'en masquer l'ouverture, s'ils le jugent à propos. Elle peut, d'ailleurs, être faite avec une très faible dépense. Elle ne laisse en outre passer, ni les paroles des voyageurs, ni les courants d'air, ni la fumée de tabac.

"En conséquence, nous pensons que, par l'application de l'article 12 de l'ordonnance du 15 novembre, 1846, on peut donner la sécurité publique, une satisfaction aussi peu dispendieuse, et inviter les compagnies à installer immédiatement, dans toutes les cloisons, une ou deux glaces dormantes, ayant un minimum 0 m. 10 de haut, sur 0 m. 25 de large, placées immédiatement au-dessous des filets à menus bagages et pouvant être recouvertes de chaque côté par une pièce d'étoffe mobile." And in reference to their proposals that the companies "*fussent invitées* à pratiquer dans le délai de six mois, dans les compartiments de première et de deuxième classe, des ouvertures fermées par une glace transparente et placées au-dessus des filets à bagages;" and that a means of communication between the guard and the engine-driver should be obligatory "*toutes* les fois que la composition des trains ne s'y opposerait pas,"—M. de Janzé remarks, "Ces demandes étaient modestes, et le sénat, comme le corps législatif, ont chaque année appelé l'attention du Gouvernement sur la nécessité de donner satisfaction aux légitimes exigences du public.

"Cependant les compartiments sont encore aujourd'hui ce qu'ils étaient il y a cinq ans, ou des cabinets particuliers, ou des cellules matelassés, étouffant les cris de douleur et d'agonie."

But, in truth, the transparency of the partition affords no remedy at all for the worst evil—the isolation of the carriages. These portions of glass only afford a more or less perfect means of seeing into an adjoining compartment; and they are rendered useless, either by a curtain drawn across them, or for a whole carriage composed of three compartments, when the centre compartment happens to be empty. They might possibly afford some deterrent protection against insult or outrage, but they would be of no use in case of accident. They would be least agreeable to passengers in long journeys, where protection is most called for, and would afford no means in general of attracting attention from the servants of the company. Even if glass were similarly inserted in the ends of the carriages, and poles were provided to attract attention by rapping from one to another, a luggage compartment, or an empty carriage, or a truck, might still be the means of cutting off communication.

The next requirement, either with or without a system of circulation, is a ready means of calling the attention of the servants of the company in any case of necessity. One difficulty which presents itself at first sight, and which has been put forward by the French Commission, and felt strongly by the sub-committee of the Clearing House, is in effect that communication without circulation is comparatively useless. The French Commission say, for instance, "Mais une réflexion qui n'a pas été assez faite, et qui domine évidemment toute la question, c'est qu'avant de donner au voyageur le moyen d'appeler à lui les agents du train, il faut d'abord donner à ces agents le moyen de se rendre auprès du voyageur, car on ne peut raisonnablement admettre qu'on arrête le train au premier signal émanant d'un compartiment. Il nous semble donc tout-à-fait prémature de mettre les voyageurs en relation avec les agents du convoi, tant qu'on n'aura pas résolu la question du contrôle de route." The sub-committee of 1853 state, "When discussing and weighing the inferences naturally deducible from the facts and information which it had collected, the committee gave its attention, in the first instance, to the important question of giving to passengers the power of communicating with the guard. Without overlooking the possibility of such an arrangement being occasionally of service, the committee have been unable to persuade themselves that it would not lead to greater disasters than it could, on any view of the matter, prevent. Unless the guards and engine-drivers had orders to stop the train whenever a passenger made a signal, the privilege would be useless to the latter. It, however, requires little acquaintance with railway travelling to be convinced that its dangers would be greatly increased if the train were to be stopped wherever and whenever a passenger, under the influence of fear or levity, chose to make a signal." And the sub-committee of 1865 quote this passage entire, and say, with regard to it:—"Upon the more important question as to whether, in the interest of the public safety, the means of communicating with the guards should be placed at the disposal of the passengers, the following extract from the Report of 1853 expresses so accurately the objections to such an arrangement that this sub-committee cannot do better than give it a place in this report."

The advantages that circulation would afford have not here been under-estimated, but, on the contrary, much space has been devoted to showing how essential it is, and to pointing out the mode by which alone it can be practically and satisfactorily obtained. And this question has been purposely kept distinct from the question of communication, because it is obvious that much confusion has hitherto been felt from combining the two problems under the one term of communication. It will be seen, on the slightest reflection, when they are treated separately, that a means of communication is even more required when there is no opportunity for circulation, than when the power of circulation exists. Without either communication or circulation, the passenger is completely isolated, and doubly helpless. Free circulation gives, of itself, an admirable means of communication. Ready communication makes up to some extent for the want of circulation.

Passenger communication must not be employed, of course, with a view to enable any passenger to stop a train at any moment. This might, as the sub-committee observe, lead to greater disasters than it could prevent. Its legitimate object would be rather to place it in the power of passengers simply to attract the attention of the servants of the company when anything was seriously wrong. And it is desirable, in this view, that the passengers should signal, not to one or more guards only, but to the engine-driver also, because, in fact, the engine-driver is principally responsible for the progress of the train while it is travelling, and it is of the utmost importance in all cases of emergency that his attention in particular should be immediately awakened. On an alarm being given, it would be for the servants of the company to act according to the best of their judgment. If a carriage were on fire, or off the rails, they would naturally stop the train at all hazards, and the engine-driver would be expected, with the help of the guards, to bring it to a stand neither more nor less suddenly than was prudent. If a train became divided, the engine-driver ought to be informed of the circumstance at once, as well as the guards, in order that he might act for the best, according to the locality, the speed at which he was travelling, and the gradients of the line. If on an alarm being given no external sign were observed of anything wrong, then it would be the duty of the engine-driver and guards, in the absence of any means of circulation, to bring the train to a stand at the nearest convenient and safe point, say under the protection of the first fixed signals. Where the power of circulation existed, the nearest guard would at once repair to the carriage whence such an alarm had been given.

In order effectually to carry out this system, it is necessary that a means should be provided of ringing a bell, or otherwise calling attention, *in* every break-van in a train and on the engine; and to render it perfect, it is desirable that each guard should be able to send a signal to, or receive one from, the engine-driver at any moment. It is further necessary, in the interest of the travelling public, as well as in that of the railway companies, that there should be a certain means of detecting the compartment from which a signal has been given. The methods proposed for effecting communication have been very numerous. They cannot here be enumerated in detail, but they may be divided as follows into a few classes:—

1. *Sound* signals, such as bells, gongs, firearms, or detonators affixed to the different carriages, connected or not with outside flags, discs, or arms to attract attention to the part of the train whence the sound proceeds. Gong signals of this sort were lately fitted up and tested experimentally by Mr. Edmund Tattersall on the London and South-Western Railway.

Such signals, requiring no extra coupling between the carriages, would be admirable if they could be made efficient. But, unfortunately, there is no certainty of their being heard, even from front to rear, in a long train; and they are frequently inaudible, under the most favourable conditions, when a train is travelling at high speed, towards the front. The rattle of a train, in passing particularly through cuttings, or tunnels, or bridges, is so great as sometimes to render the steam whistle of the engine inaudible to the guard in his van.

On this point the Clearing House Sub-committee of 1853 observe: —"29. The remarks made in a former part of this report, when treating of air whistles, prove that signals depending on sound, if made at a distance from the engine-driver, are as little to be relied on as those depending on sight. Several members of the committee have at various times conducted experiments having sound for their basis; and the result has invariably been that no noise, however loud, shrill, or continued, whether the sound was produced by compressed air, trumpets, or gunpowder, could be heard, even when the train was short, when there was a head wind, or when the speed of the train was considerable."

Of this class, also, those which depend upon gunpowder, or explosive compositions, would be liable, after lying ready, perhaps, for years, to fail when they were required for use.

2. *Sight* signals for day and night on the different carriages, independently of sound. These signals have also the advantage of requiring no extra coupling between the carriages, but a servant of the company must always be specially on the look-out for them.

The system of employing a travelling porter or look-out man was advocated for many years, and employed with some trains, by the Great Western Company; and the look-out box which was constructed at the back of the tender for his accommodation, must be familiar to all who have been in the habit of travelling on that line. But there have been several accidents, including the two above referred to, in which the travelling porter, much required, was not forthcoming. And there are many disadvantages attending such a system. It is difficult to keep a staff of men on different trains always carefully on the look-out for what is very seldom seen, and expensive to employ them for this sole purpose. They would be unable to see along the trains, or to distinguish any signals made to them, during fogs or in the steam and smoke of tunnels. The engine-drivers and firemen have quite enough to do in attending to the engine and looking out ahead, and it would be in the highest degree dangerous to make them responsible for watching at the same time the carriages behind them. The guard or guards have letters, parcels, and luggage to sort and look after, and cannot be expected to keep a constant look-out on the journey.

It has frequently been proposed to place mirrors in various positions on the engine or in the breakvans, in which the whole train shall be reflected, for the benefit of either the engine-driver or the guards, or both; and the experiment was tried in France, on the Montpellier à Cette railway. There has been a further scheme for providing systems of mirrors, by which the interior of every compartment of every carriage in a train should be rendered always visible from the vans of the guards. But these mirrors would require to be frequently cleaned on the journey. Either at the side of the engine or at that of the van they would extend, if of any use, to an inconvenient distance. None of the servants of the company could be expected to be constantly looking into them; and a system of supervision which rendered the interiors of the different compartments constantly visible to persons who could not be seen from them would, even if it could be rendered suitable for adoption in practice, be disagreeable to passengers of both sexes.

The French Commission before referred to remark with regard to the above two classes of signals:—"Les n^{os} 2, 3, 14, 24, consistent des appareils visuels ou sonores placés sur les voitures des voyageurs. Nous démontrons que leurs signaux visuels ne seraient point vus, que leurs signaux sonores ne seraient point entendus."

3. *Apparatus* worked by the *revolving axles* of any of the vehicles of a train. These, whether air-pumps, or magnetic, or other arrangements, require to be adjusted to extreme variations of speed, and are useless when the wheels are skidded by breaks, in slackening speed, or in descending steep inclines. There are difficulties also in arranging most of the apparatus so as effectually to communicate both

between the passengers and the servants of the company, and between the latter only. It is further desirable that the machinery of communication should be independent of the machinery of the train.

4. *Tubes* throughout the trains for various purposes. There is no difficulty in coupling them together between the carriages, except when they are required for steam from the engine at high pressure. The couplings then, besides becoming hot, are too delicate for the rough work of being constantly interfered with by the porters in the course of traffic. The waste of steam, also, both directly and from condensation, and the risk of accident to the porters in coupling and uncoupling, are amongst their disadvantages for such a purpose. The use of tubes for the conveyance of balls, numbered or lettered, by a direct current always passing from the passengers to the guard, and by a reversed current from the guard to the engine-driver, has been tested on the London and North-Western Railway. As originally devised, they necessitate the constant working of an air-pump in every break-van, which is open to the objections mentioned in No. 3; and no other satisfactory mode of obtaining the necessary current has been proposed. Tubes for the conveyance of sound, by whistle or otherwise, have not yet been properly tested, but the French Commission remarks with regard to them,—"Les n^{os} 17, 26, 28 et 29, croient à l'efficacité de tuyaux acoustiques communiquant sur toute la longeur du train. Il est facile de démontrer que ce système de communication serait au contraire entièrement inefficace."

5. *Apparatus* worked by the *resistance of the atmosphere* during the passage of a train have hitherto proved, and are likely to prove, a failure, because the amount of resistance varies so much, according to circumstances, and the power obtained depends, not only on the speed of the train, but also upon the force and direction of the wind.

6. *Cords* or *wires* connected with whistles or bells on the engines or tenders. These have been extensively used both in this country and on the Continent as means of communication between the guards and engine-drivers, as well as in America, where they run along under the roofs of the carriages. They were recommended for adoption outside the carriages by the first sub-committee of railway managers, who reported in 1853, and they have since done good service, though they have been roughly applied, and have been known occasionally to fail in very long trains. They are not well adapted for further complication, such as connection with the several compartments of every carriage in a train, and a detector in each. Numerous projects of this sort have, however, been brought forward, and an attempt has been made to carry out one of them on the Great Northern Railway.

7. *Voltaic apparatus* appears, on the whole, to be the best adapted for complete inter-communication, though it has the disadvantage of being worked by batteries, which require to be examined—say once a month, and renewed – say every six months. The only arrangement that has yet, as far as we are aware, worked successfully upon a train on this (or any other) system, is by Messrs. Preece and Bedborough, on the London and South-Western Railway. The Exeter express train at 10.50 A.M. from the Waterloo terminus, now runs with it on Mon-

days, Wednesdays, and Fridays. Three trains, as well as all the state and saloon carriages of the company, have been supplied with it, and a fourth train is in hand. The voltaic circuit is carried through the trains by means of one wire under each vehicle, bifurcated as shown in Fig. 1, and connected with a coupling, and a coupling-hook, at each end of each vehicle, to provide for its running in either direction, and to ensure more perfect action. The earth connection passes through the wheels, and the batteries and bells are so arranged —as shown in Fig. 2—that they are quiescent as long as the wire is *clear*, but that if the wire be put "to earth" at any one point, every bell will ring throughout a train. The couplings between the carriages, which are shown in diagram 4* (Plate), have already been used for some time in France, on the Chemin-de-fer du Nord.

Fig. 1.

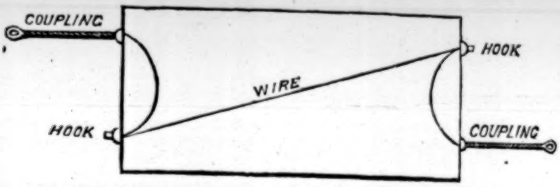
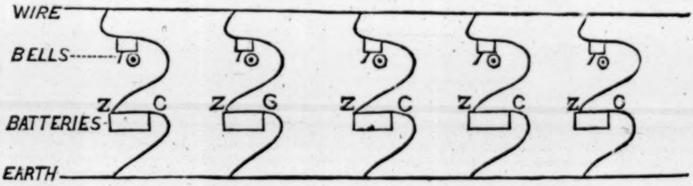


Fig. 2.



The coupling-hook (A) is of gun metal, and is kept from contact with a knob (B) of similar metal above it, as long as the eye (C) is upon it; but, as soon as the carriages become detached, the eye is pulled off the hook, the hook is forced up by the action of a self-contained spring against the knob, and the circuit being thus completed, the bells are rung throughout the train.

According to the latest modifications, there is no signal from the carriages either for day or for night, it being considered that whenever anything serious is the matter, the passengers will themselves direct attention to the carriage, in all cases in which no defect is visible to the servants of the company. Much expense is thus saved.

The bells in the guard's van and on the engine, are *trembling* bells, ringing incessantly as long as the current is maintained. The electro-magnet (H), acting upon the armature (E), causes the striker (C) to strike the gong (D) under the action of the current; and the bells

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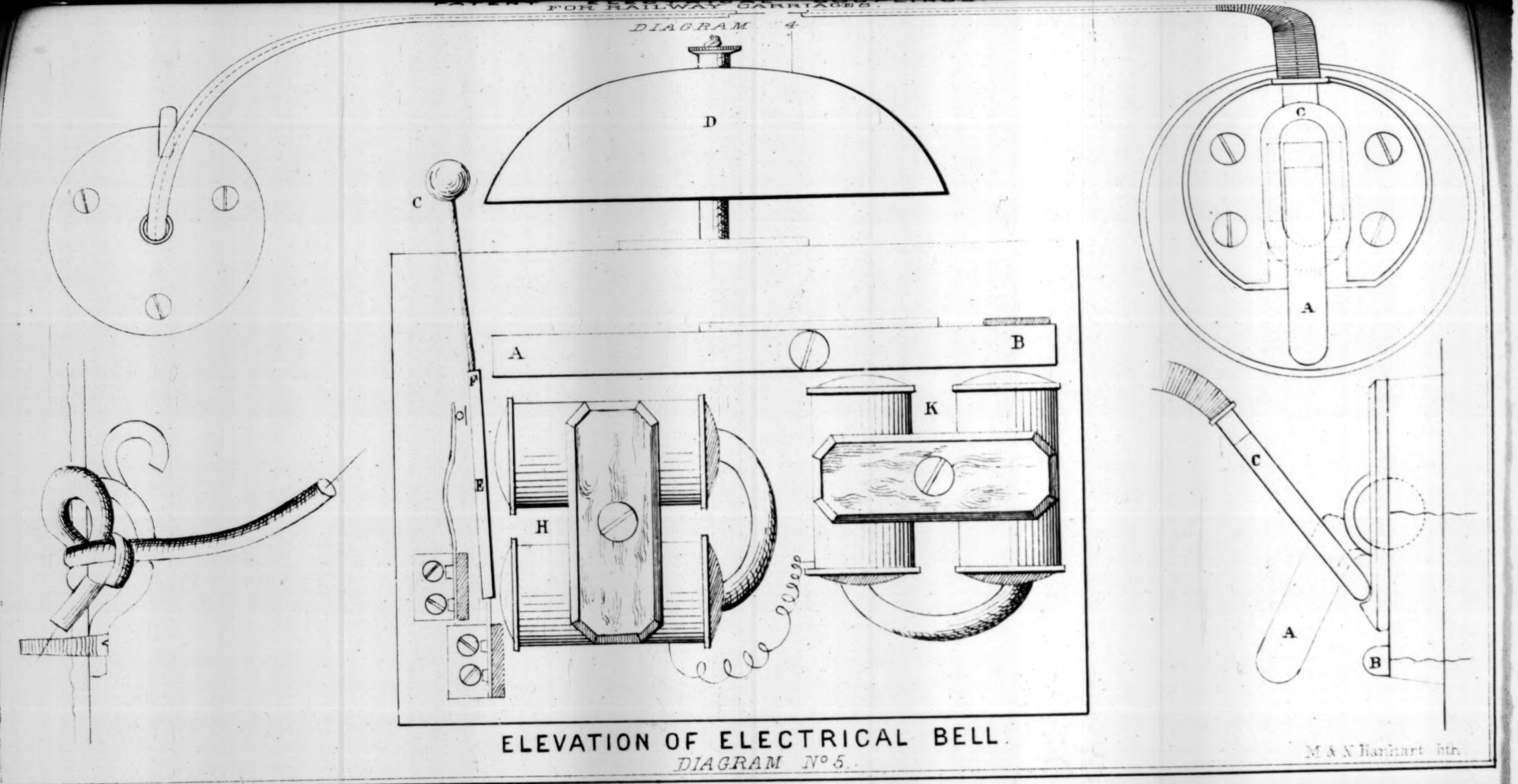
* This diagram has unfortunately been turned upside down by the lithographer, and the reader will therefore understand it better by reversing it.

FOR RAILWAY CARRIAGES.

DIAGRAM 4



ELEVATION OF ELECTRICAL BELL.

DIAGRAM N°5.

M & N Hanhart lith.

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are prevented from ringing by the oscillation of the train, when the circuit is incomplete, by a simple and ingenious device. A stop-bar (A B), part of which forms the armature of a second electro-magnet (K), falls, and interposes (at F) to prevent the striker (C) from coming in contact with the gong (D) when the current ceases, and is lifted out of the way by the action of electro-magnet (K) upon armature (B) when the current passes.

The instrument to be acted upon by the passengers is simply a circular box affixed to the partition in each compartment of each carriage, with a convex glass face, covering a handle. In case of alarm, the passenger breaks the glass face, and moves the handle in the direction of an arrow. This completes the circuit and causes the bells to ring on the engine and in the guard's van, and they continue ringing until the apparatus is refixed by the guard. The fractured glass forms, of itself, an excellent detector. [The regulations which have been issued by the Company, being the first of the sort, are given in the Appendix.]

A young lady, Miss Gordon, of Prince's Gate, who has taken more pains in making herself thoroughly acquainted with the subject than almost any inventor of the stronger sex, has also proposed a system of voltaic communication through passenger trains. She has constructed a special train-telegraph coupling. She has designed a cheap form of telegraph-bell, intended, by repeated beats, either for making special signals, or for giving alarm signals; and she would employ it, not only for inter-communication in the trains, but also for communicating in cases of emergency between a train and the stations on either side of it. She further proposes, as an auxiliary to safety in some cases, to make each train record its movements past certain points, so that a fixed signalman may, as it were, watch its progress on a dial in his cabin long after it has passed out of his sight, or receive indication of its distant approach.

Whatever system may be used, it appears desirable that the handle, or button, or tassel, to be acted upon by the passengers, should be placed under glass; in order that it may not run any risk of being interfered with except in a case of necessity. An uncovered tassel or handle would be liable to be trifled with, and to be set in action thoughtlessly or unintentionally by a child, or too easily by a nervous passenger; whereas a glass, used as a cover, which could not be replaced, would only be broken under the pressure of considerable alarm. The keys of the doors of some of the French carriages have for years been placed in the compartments, protected in this manner, for the use of the passengers in case of necessity.

These questions of circulation and communication in trains have formed from time to time, as accidents have taken place or offences committed, a subject of recommendation by the Railway Commission and the Board of Trade, of discussion by Railway managers, of remonstrance by the public, and of projects by inventors, for the last twenty years. During that time circumstances have materially altered, but the want has become, upon the whole, more and more apparent. We are now labouring under great disadvantages, because the rolling stock has hitherto been constructed independently on the different railways, without any provision for a suitable system; and the evil will, if it is unchecked, inevitably grow worse as years roll on. It is therefore desirable, that further delay should be avoided, and that measures should now be adopted for securing, within a reasonable time, the adoption of some general and appropriate remedy.

It cannot be expected that the directors or officers of railway companies, who are all under pressure, more or less, from their shareholders, should initiate such a remedy; nor can it be supposed that so many companies would all agree with one another as to what would be most expedient; but it is not probable, after all that has passed, and looking to the exigencies of the future, that the railway interest would combine seriously to oppose any well-considered scheme which might be proposed to Parliament. And indeed, the sub-committee of this year goes so far as to express an opinion "that it is desirable if practicable, to give passengers by express or other trains, running for a considerable distance without stopping, the means, in cases of emergency, of attracting the attention of the guard, and of enabling him to stop the train at the next station, or under the protection of the next fixed signals, and they recommend that no effort should be spared on the part of the railway companies to attain this object, it being borne in mind that, in order to give the public the full advantage of the communication upon the long through trains, many of which traverse several lines of railways, it is absolutely necessary that all the companies should adopt the same plan." We have, however, already explained why it is desirable that the engine-driver should have the advantage, as well as the guard, of hearing any signal that a passenger might make, not by any means as a direction to him to stop the train, but in order that he may be in a position to act for the best, according to circumstances, without loss of time, in a case of real emergency.

As a summary of what has been said, it would appear, upon the whole, to be desirable:—1. That no passenger vehicles should be constructed henceforward for railways except such as will afford the means of internal circulation through the trains. 2. That all existing passenger vehicles should also within some fixed number of years be made to afford internal circulation through the trains. 3. That all vehicles used in passenger trains should within some stated time be fitted with the means of voltaic communication, so that a passenger shall, in a case of emergency, have the power, from any compartment, of attracting the attention of the engine-driver and the guard or guards. 4. That any passenger wilfully and wrongfully making use of such communication shall be liable to a penalty on conviction.

It would serve no good purpose to enter further here into the details of such arrangements; but it may be added in conclusion, that the combined means of communication and circulation which are contemplated, would be principally deterrent as regards offences, from the comparative certainty of detection which they would afford; occasionally useful in preventing or alleviating the disastrous effects of accidents; and undoubtedly advantageous, both to the country and to the railway companies, in affording increased confidence, and therefore promoting extra travelling, on the part of the public.

APPENDIX.

Copy of Instructions to Enginemen, Guards, and all Parties concerned on the South-Western Railway.

Electric Communication between Passengers and Guard.

Some of the trains are now fitted up with an electric communication between passengers and guards. In the event of something of a *serious nature* occurring, which URGENTLY requires the stoppage of the train, the passenger may "break the glass," "and Ring" by moving the bell handle in the direction denoted by the arrow:—Thereby a bell will ring in each guard's van in the train, and also on the engine.

When the guards and enginemen hear the bell ring, they will at once *look carefully along each side of the train*, and in case any violent oscillation be seen, or a carriage be on fire, or other occurrence of a serious character be observed, *the train will be stopped* as speedily as possible, and, when stopped, must be protected by signals as prescribed by the Rule book.

Should, however, the guards and enginemen fail to observe anything *which really necessitates an immediate stoppage* of the train, their duty will be to stop the train at the next station or junction, so as to protect the train, when stopped, by fixed signals.

When the train is stopped the passenger who broke the glass and rang the bell will communicate with the guard; but should he fail to do so, the guard will detect the compartment from which the passenger gave the alarm by looking for the broken glass, and in case the alarm has been mischievously and wantonly given, or from insufficient cause, the names and addresses of all the passengers in that compartment will be taken, in order that the law may be enforced.

The Bell Signal Code between Guards and Enginemen is as follows:—

One Beat	Acknowledgment.
Two Beats	Go on; all right.
Three Beats	Look out; something wrong.
Four Beats	Shut off steam; pull up, and stop at next station or junction.
Six Beats	Danger; stop at once.

Every signal must be acknowledged. The acknowledgment by enginemen will be given by one whistle.

London, 10th August, 1865.

ON THE QUALITY OF MUSICAL SOUNDS.

By W. Stevens Squire, Ph.D., F.C.S.

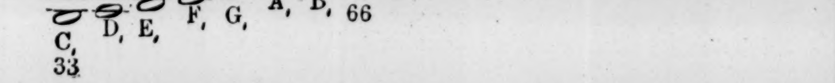
Though Music, as an art, is tolerably ancient, the investigation of the physical principles upon which it depends has only just commenced. There is, perhaps, no art in which physics come so much into play. With the exception of the human voice, which is itself the most delicately constructed instrument imaginable, nothing can be done in music without artificial apparatus, generally of a highly complex character, requiring as much skill on the part of the workman as the most delicate philosophical instrument. This apparatus is constructed with the greatest care, in order to produce certain musical effects which are characteristic of each kind of instrument, and the slightest uncertainty in the quality of the sound will make the difference between a good and bad instrument.

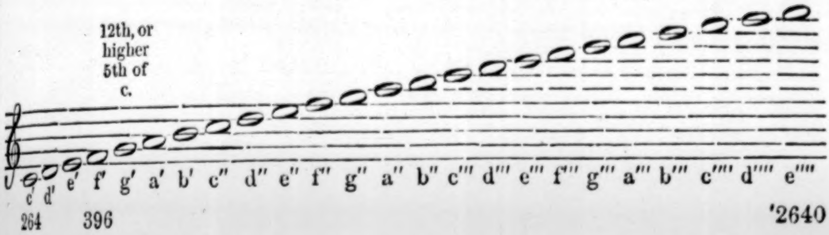
It would be supposed that the physical principles involved in so delicate a matter would be, to a certain extent at least, understood by the workman or the manufacturer, but, strange to say, this is not the case. Although the various musical instruments in use at present have been constantly improved until the quality of the sound leaves little to be desired, all this excellence appears to be the result of pure empiricism, of experiment, and of the rule of thumb. It is only in the last few years that any serious attempts have been made to ascertain on what the quality of sound depends, and, indeed, what it is that is meant by the term quality. Among these workers Professor Helmholtz, of Heidelberg, occupies the foremost place. He has been enabled, by means of peculiar apparatus devised by himself, to analyze various kinds of sounds, and to determine the nature of that property of sound which is called quality.

Musical sounds differ in pitch and in loudness. The pitch is regulated by the frequency, and the loudness by the extent, of the vibrations; but though the pitch and the loudness may be the same, the sound of a violin differs very greatly from that of the trumpet on the one hand, and from the flute or tuning-fork on the other; that is, though the same for musical purposes in all other respects, the quality is different.

The following tables will be found useful for indicating the number of vibrations requisite for, and the names of the notes in the musical scale, as it will frequently be necessary to mention them by name, and it would be inconvenient to have recourse to the staff:—

Notes.	C B	C B	c b	c' b'	c'' b''	c''' b'''	c'''' b''''
C	33	66	132	264	528	1056	2112
D	37·125	74·25	148·5	297	594	1188	2376
E	41·25	82·5	165	330	660	1320	2640
F	44	88	176	352	704	1408	2816
G	49·5	99	198	396	792	1584	3168
A	55	110	220	440	880	1760	3520
B	61·875	123·75	247·5	495	990	1980	3960




12th, or higher 5th of c.
c' d' e' f' g' a' b' c'' d'' e'' f'' g'' a'' b'' c''' d''' e''' f''' g''' a''' b''' c'''' d'''' e''''
264
396
'2640

It is obvious from these tables, that if a vibrating body makes, for example, 132 oscillations per second, it will produce the note c, and, for anything that appears to the contrary, this effect is quite independent of the nature of the vibrating body; the greater or less violence of the vibration will merely affect its loudness, so that the simple undulatory theory of sound offers no explanation of what has hitherto been a mystery—its quality. This we must seek in some modification of the phenomenon. The table contemplates the case of a vibrating body; a string, for example, vibrating in regular periods in a pendulum-like way as a whole, and provided it does this in practice, it is clear that all sounds of similar pitch would be alike, whatever their source. But a closer examination of the vibrations of elastic bodies discloses some peculiarities of motion, which must seriously modify the effect. If we suppose a string stretched with a certain tension between two fixed points (A, B, Fig. 1), and that it is caused to vibrate as a whole, which may be done by plucking it at the point *a*, it will vibrate as in Fig. 2, producing a certain note—say C. But if instead of plucking it at *a* the finger be gently laid on that

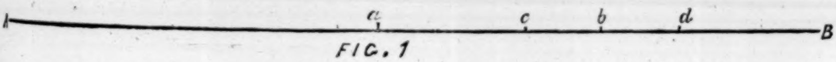
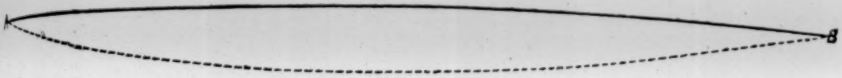


FIG. 1



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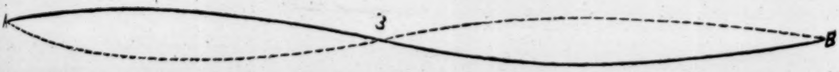

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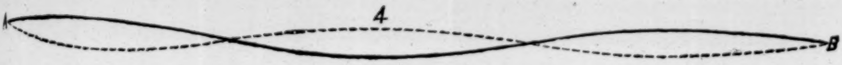

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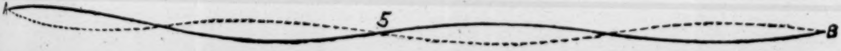

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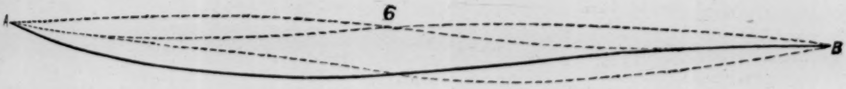


6

point and the string be plucked at *b*, and the finger immediately removed from *a*, the string will divide itself into two equal portions, each vibrating twice as fast as before, producing therefore the higher octave c, as in Fig. 3. If it be touched at *b* and plucked at *d* it divides itself into three portions, each moving three times as fast, and giving the twelfth of C, *viz.* g, Fig. 4, and so on for Fig. 5, which represents the second octave of C, c″. But the movement of a string is not limited to any single one of these forms of vibrations. It may partake of all or any; thus, a string may be divided into two, as in Fig. 2, and likewise vibrate as a whole, so that a phenomenon would be presented something like that shown in Fig. 6, where the string gives both the sound of C its fundamental tone, and also that of c, which is one of its upper tones.

In this case the node or fixed point *a* of the upper octave c is itself vibrating so as to produce C. It is obvious that the portions representing the higher octave may be themselves divided so as to produce the second octave c′, and the string would then simultaneously emit three sounds, C c and c′.

These secondary vibrations may vary much among themselves in intensity, that is, in their amplitude of oscillation, so that a string may give its fundamental note supplemented by upper tones, some of which will enter into the sound in greater strength than others, but as a rule those upper tones which lie nearest in the scale to the fundamental will be the most powerful, as they require a greater length of string and are therefore capable of oscillations of greater amplitude. But this is not always the case, the second, third, or fourth tone being sometimes more powerful than the fundamental itself.

This series of harmonic upper tones is always the same for all musical instruments, and is as follows:—

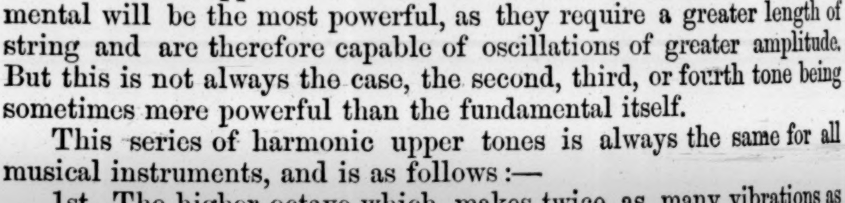
1st. The higher octave which makes twice as many vibrations as the fundamental note. If we suppose the key-note to be c, this higher octave would be c′.

2nd. The fifth of this higher octave g′, which makes nine times as many vibrations as c.

3rd. The second higher octave c″, which makes four times as many vibrations.

4th. The major third of the octave c″, with five times as many vibrations.

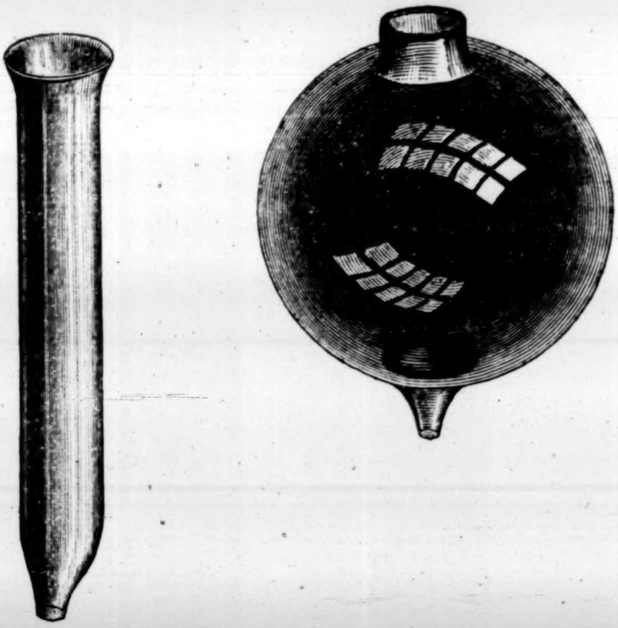
5th. The fifth of this octave, with six times as many, and so on to tones which require seven, eight, or nine times as many vibrations. Expressed in the musical scale, we have



It is not every ear that can, without great attention and practice, distinguish these upper tones in the sounds of musical instruments.

Still they had been observed long ago, particularly in the violin and violoncello, but were regarded as curious facts without any suspicion of their real importance. To distinguish them accurately and determine their intensity and pitch, requires an artificial help, which is supplied by the resonators of Helmholtz. These consist of glass globes, or very wide tubes, with an opening at each end, as in Fig. 7.

FIG. 7.



The smaller opening is made to fit accurately into the ear by means of a covering of sealing-wax, which is pressed while still warm into the opening of the ear, so as to take its exact form. Instruments of this kind possess the property of resounding and intensifying those sounds, and those sounds only, which are called forth by blowing across the wide opening. They are made of various sizes, each corresponding to a particular note in the scale. When one of these instruments is applied to the ear, and the other ear is perfectly closed, scarcely anything is heard of the external sounds, unless a sound be present of precisely that pitch which corresponds to the resonance of the globe when it bursts at once loudly on the ear. By means of this contrivance a complete analysis can be made of a mixed sound, resolving it into its fundamental and attendant train of upper tones.

It is to these secondary tones that we must ascribe what is called the peculiar quality of the sound. As they are present in greater or less proportion, so the sound is fuller or duller, just as a single note struck on a pianoforte is thin and poor, but is rich when supplemented by its chord, so the simple fundamental note is modified by the upper tones by which it is accompanied. Indeed the first six harmonic upper tones must be looked upon from a musical point of view as a major chord in which the key-note is the most powerful. These upper tones may be either harmonic or inharmonic, harmonic if their vibrations are simple multiples of those of the fundamental, inharmonic when no such simple relation exists. There is scarcely any musical instrument which is free from these upper tones; the tuning-fork is nearly so, and those which are produced when the fork is first struck lie so far from the fundamental, that they speedily disappear and leave a perfectly simple sound as the characteristic of this instrument.

When a stream of air is directed across a wide tube, closed at the bottom and provided with a narrow opening at the top (such as a bottle), a tone is produced which is also free from upper tones. Again, by applying the handle of a tuning-fork to the end of a string so stretched as to be in perfect unison with it, the string takes up a pure pendulum-like vibration free from nodes, and gives also a simple sound. As might be expected from what has been said, these sounds, produced in three different ways and perfectly alike, are undistinguishable the one from the other. It is strictly true that could we eliminate altogether the upper tones of the various instruments used for musical purposes, they would all give nothing but the dull soft sound characteristic of the tuning-fork.

So long as the upper tones are harmonic to the fundamental they give it a peculiar rich quality by supporting it. As their vibrations are simple multiples of those of the fundamental, it is obvious that at certain regularly recurring intervals their vibration must be identical with that of the fundamental, so that like impulses applied at the proper moment to a swinging pendulum the action is increased and maintained. When the upper tones are inharmonic they give a peculiar piercing metallic character to the sounds, which is characteristic of instruments so situated.

The only cases in which the upper tones are strictly harmonic to the principal tone are vibrating strings and vibrating columns of air, and hence we find that musical instruments depend almost exclusively on these two means of producing sound.

Sounds produced in other ways are always accompanied by secondary inharmonic tones, and are only used by the musician when the fundamental is far more powerful than the secondary tones, in military and dance music, to mark the time or on account of their piercing quality. The tuning-fork itself is an instrument producing inharmonic upper tones, which are, however, so high and lie so far apart, and, moreover, are after a few moments so weak, that the principal tone is almost the only one which is appreciable. Vibrating bars of metal or other material are sometimes used in another form, either suspended perfectly free as in the triangle, or supported at the *nodes* of their principal tone as in the glass harmonicon.

Here the material of the bar has only just so much influence on the sound as depends upon its mass or elasticity. The high inharmonic tones will last longer in bodies of considerable mass and great elasticity, such as steel and certain alloys of copper; and on this account these bodies produce a peculiar sharp, clear sound, which is aptly termed metallic. The quality of sound from glass is fuller and freer from the shrillness of the high upper tones, partly on account of its smaller mass and partly because it will not stand so hard a blow. Wood is still lighter, and is in its internal structure full of countless hollow spaces, and therefore of less elasticity, so that the secondary tones soon cease, and the sound is pleasanter to the musical ear. In all these cases hammers of cork or wood covered with leather are employed, for by these means the higher upper tones are rendered weaker than they would be with a metal hammer: but of this we shall speak more fully when considering the pianoforte. The vibrations of bars or metal discs and stretched membranes are capable of very exact mathematical calculation, but a consideration of these would lead us too far.

Metal discs are only used in the form of cymbals, which produce inharmonic upper tones of a very varied character, and bells may be considered also as belonging to this class, but the upper tones though inharmonious lie closer together. It is the great art of the bell-founder to render the lower upper tones as nearly as possible harmonic to the fundamental, which has been done by means of a peculiar form empirically discovered. By these means the tone of the bell is softened, but the precise theory of the form has yet to be worked out.

Of instruments with inharmonic upper tones we may say generally, that if these lie near in the musical scale to the fundamental the effect is to a high degree unmusical, bad, and kettle-like, as in cymbals. If, on the contrary, they lie tolerably wide, as in the tuning-fork, glass harmonicon, and bells (in which latter those which lie near to the fundamental are made harmonic), they may be used for marches, &c., but are rightly banished from classical music. Even if the harmonic upper tones disappear quickly they disturb the harmony exceedingly, so that the bell-playing of the Yorkshire ringers, who have attained to great proficiency, may be a curious but is by no means an agreeable performance.

Sounds with harmonic upper tones are produced in four ways: (1) By striking a string in a state of tension, or (2) by drawing a bow across it; (3) by setting a column of air in vibration by blowing against a sharp edge, or (4) by blowing against an elastic tongue (reeds). The instruments which belong to the first class are pianofortes, harps, and guitars, and we must also add the pizzicato of violins. The upper tones in the sound of an instrument of percussion depend upon—

1st. The kind of blow,
2nd. The place where the blow is delivered,
3rd. The thickness, rigidity, and elasticity of the string.

As far as the kind of blow is concerned, the string can either be drawn aside and then released, as in the harp or guitar; or by means of a plectrum, as in the ancient lyre and the modern Hungarian zitter; or the string may be struck with a hammer, as in the piano. It is easy at once to see that the effects will be very different. When the string is drawn aside, the whole string is removed from its position of equilibrium, so that when it is released the vibration will be chiefly confined to the string as a whole, that is, the fundamental will far exceed in power the upper tones. If, on the contrary, the string is struck by a hammer which springs away immediately, it is only just that portion which was immediately in contact with the hammer that is set in motion.

Immediately after the blow, the other part of the string is at rest, and is only disturbed by the wave which is set up at the point of percussion, and which is propagated to the end of the string, and reflected back again like a wave on a trough of water, producing a long series of upper tones, the intensity of which may equal or even surpass that of the fundamental. The harder and lighter the hammer, the more quickly will it be thrown off, and the shorter will be the length of string displaced at the moment of impact, so that the fundamental might be quite inaudible, and the sound shrill, thin, and of disagreeable quality. To obviate this, it has been found advantageous to cover the hammers with soft felt. At the moment of first impact the felt is compressed so that the force is gradually applied, and it is only when a considerable length of the string is in motion that the whole of the force has been expended and the hammer thrown off. The thicker the felt and the heavier the hammer the longer will it remain in contact with the string; accordingly these conditions are observed in the lower octaves of the pianoforte, where the strings are long and heavy, and a proportionately greater mass must be set in motion in order to get rid of the high upper tones which would spoil the rich deep quality required. The time that the hammer is in contact with the string, to a great extent regulates the upper tones produced, for it is clear that there will be a tendency to produce just those tones which require an excursion of the string in one direction in the time, or in an even multiple of the time, that the hammer is pressing the string in one direction.

The place at which the blow is delivered exercises an important influence in this respect, as none of those tones which have a node (or place of rest) at this point can be produced. On the other hand, those which have their maximum of oscillation about this point will come prominently forward. Thus, if the string be struck exactly in the middle, the fundamental which has its greatest amplitude here will be most powerful, but the next octave will be wholly wanting the 12th, *i.e.* the 5th of the higher octave (the third tone) will be prominent, but the 2nd octave will not be produced, that is, the tones of the even numbers will be absent, but those of the uneven numbers will be present. The effect of this is to give the sound a dull nasal character. Now the first six tones come exactly into what is called the major chord, that is, they are all thirds, fifths, and octaves, but the seventh tone, which is a minor seventh, and the ninth, which is a minor second, do not come into the chord. Theory, therefore, indicates that the place at which the string should be struck is that at which these tones have a node. Such a point is situated about the seventh from the end of the string, and this is the place actually adopted by the manufacturers. No theory has led them to this, but by blind experimenting they have arrived at the same practical conclusion that theory points out.

Lastly, the thickness and material of the strings have considerable influence on the quality of the sound, for very stiff strings cannot give such high upper tones as thinner ones, because they are not capable of subdividing themselves into such minute flexible portions. With a very thin wire, such as is used for artificial flower-making, it is possible to obtain the 18th tone if the string is 7 or 8 yards long, but these high tones no longer belong to the major chord, and produce that peculiar wiry tone characteristic of instruments such as the zitter, with very thin wires. The elasticity of gut strings is far less than that of wires of similar thickness, so that the high upper tones disappear at once, and the sound is fuller and rounder.

The theory of fiddles is not so complete as that of the piano, as the peculiar action of the bow, which is not well understood, will greatly influence the quality of the sound. The string is drawn by the friction of the bow from its position of equilibrium, and as soon as the tension overcomes the friction it is suddenly released, so that the motion rather resembles that of a tilt hammer, slow in the one direction, but quick in the other. The fundamental is proportionately stronger in these instruments than in those in which the string is struck near the end, as in guitars and pianos, the lower upper tones are weaker, but the higher tones, from the sixth to about the tenth, are much more distinct, and to these are due the peculiar clearness of the sound. The form of the vibration is in the main tolerably independent of the place where the bow is used, still minute variations arise from this cause. If, for example, the bow is drawn across a portion of the string which corresponds with a node of one of the higher tones, that tone will be wanting, and variations in the quality are partly dependent on this circumstance. So that if the bow is used too near the finger board, the end of which is about one-fifth of the length of the string from the bridge, the fifth or sixth tone will be absent, which ought otherwise to be audible, and the sound will be duller. The usual position of the bow is about one-tenth from the bridge, for piano passages rather farther, for forte rather nearer. If the bow is used very near the bridge, about one-twentieth, it is possible to produce by a gentle and rapid movement only the higher octave, so that a node is produced in the middle of the string, just as if it had been lightly touched by the finger at that point, and between this point and the usual place every possible mixture of the primary tone and its higher octave may be obtained.

In the quality of the tone of the violin, much is supposed to depend upon the wood of which it is made, and this is unquestionably true. Still both age and long use of the instrument tend to increase the elasticity of the wood, which is, perhaps, one reason for the preference accorded to the instruments of the old makers. The sound of the violin does not come to us direct from the strings, but from the body of the instrument. The one leg of the bridge rests on a rod of wood joining the upper and lower surface, the other rests unsupported on the upper wooden surface, and this conveys to it the vibrations of the strings, which are again transmitted to the air by the greater surface of the wood. But a hollow space enclosed by elastic walls like those of the violin must have certain proper tones which may be evoked by blowing into the openings. Savart found this to be for the violin c′ and for the violoncello F. This will have the effect of strengthening those tones which approximate to those of the hollow space, and it is found both in the violin and violoncello that these tones come broadly out. As the lowest note of a violin is g, it is only the upper tones of the three lowest notes which will be increased by resonance, while of the other notes generally, the fundamental will be augmented rather than the upper tones, as they approximate more to the peculiar tone of the body of the instrument.

The pipes of an organ consist of two parts, a sharp edge against which a current of air is driven, and a hollow pipe which may be either closed or open at the top. These pipes act in a similar way to the resonators of Helmholtz. The air when driven against the sharp edge, produces a kind of whistling hissing noise, which consists of unharmonic tones lying tolerably close together. The pipe itself is capable of strengthing, by its resonance, just those tones and those only which are either its fundamental or its harmonic upper tones. All other sounds remain unaffected, and are almost completely masked by the increased power of those fortified by the pipe. By blowing very hard the pitch of the noise is raised and the fundamental may disappear, and only the upper tones remain. A flute is in precisely the same predicament as an organ pipe—certain tones produced in the noise made by blowing across the holes are strengthened by the tube, which may be made shorter or longer by closing the holes. A flute, when gently blown with all the holes closed, gives d′, by stronger blowing d″, by still stronger a″, or even d‴—the series of harmonic upper tones of d′. In those parts of the organ consisting of narrow cylindrical pipes the fundamentals are accompanied by very clear powerful upper tones, which produce that sharp fiddle-like character of the Viola di Gamba and other stops; by the help of the resonators the sixth upper tone may be clearly distinguished, a tone which is also very powerful in the fiddles themselves. In the wide pipes there is far less tendency to fortify the higher upper tones, so that these pipes will bear much harder blowing than the narrow ones without starting into upper tones, and on this account, and because the vibrating mass of air is large, they are used to produce the chief volume of sound, and are called principals. In the wooden principals the second tone (the octave) is easily recognized, the third (the higher fifth) is weak, and the still higher ones are no longer audible. In the metallic principals they are found as high as the fourth tone. The quality of tone in these pipes is fuller and softer and less shrill than in the narrow ones (violin principals). By narrowing the upper end of the tubes the fifth and seventh tones become more prominent, and the sound is on this account thin, but clear and brilliant. The narrow closed pipes are characterized by the higher tones of the *uneven* numbers—the third, fifth, and seventh upper tones. The wide closed pipes are almost free from any upper tones whatever, so that the quality will resemble that of the tuning-fork. Sometimes a small tube open at both ends is inserted into the cover of a closed pipe, and it is of such a length that its proper tone corresponds to one of the upper tones (generally the fifth) of the closed pipes, so that the sound acquires a peculiar clearness. The absence of the upper tones of the even numbers gives the sound of closed pipes a certain dullness in comparison with that of open ones, but they form an excellent contrast to the shrillness of the latter.

The sides of wooden pipes are not so well fitted as those of metal ones to resist the vibrations of the air, and the higher tones are therefore quickly extinguished, so that the sound of these pipes is always somewhat dull.

In the so-called reed pipes the noise, to be purified and strengthened by the pipe, is produced by the vibrations of a tongue of metal or wood vibrating in a slit, which it closes or nearly so. When set in motion by air blown through the slit, it admits at each vibration a puff so as to produce a series of periodic impulses, which, acting on the column of air in the pipes, sets it in a state of vibration. In the organ and harmonium these reeds are of metal; in the oboe and clarinet, of wood. A similar arrangement may be produced by the use of elastic membranes stretched across an opening, closing it when at rest, but during the passage of a current of air they are forced asunder, and again return to close it by their elasticity. This arrangement occurs in practical music in two forms—in human lips when blowing brass instruments, and in the larynx when singing. The lips may be regarded as very slightly elastic membranous bodies, heavily weighted with unelastic tissue, which by themselves would vibrate very slowly, but used together as a means of producing a series of puffs they are capable of producing a tolerably high tone. The vocal chords are similar, but they have this great advantage over all other reed instruments: that the opening of the slit, the tension, and even the form, can be altered at will with great rapidity and precision. In addition to this the form of the resonance tube, which is here represented by the cavity of the mouth, can be changed so as to produce a greater variety of sounds than any other instrument. The metal reeds of the organ and harmonium are only intended to produce a note of a certain fixed pitch. On these heavy and rigid reeds the vibrating column of air in the pipe has but little reciprocating influence, and such instruments must have a separate reed for every pipe. In the wooden reed instrument there is but one reed, which must serve for the whole series of notes. These reeds are made of a light, elastic wood, and from their lightness they are themselves affected by the vibrations of air they have set up in the tube. They are capable not only of giving the high notes corresponding to the periodicity of the reeds, but also of exciting much lower notes when the tube is lengthened by closing the holes. Under these circumstances the vibrations are sufficiently powerful to carry the reed with them, and the pitch is regulated by the length of the tube, and not by the oscillations of the reed. The clarinet has a cylindrical tube, which is practically closed at the top, and it is subject to the same laws which regulate vibrations in closed organ pipes; that is, the upper tones of the even numbers are wanting, so that by blowing strongly the pitch may be raised a twelfth, but not an octave, as in the flute, because the octave is a tone of the even numbers. The tube of the oboe is conical, and conical tubes closed at the point have nearly the same peculiarities as open pipes of the same length; accordingly we find in this instrument the whole series of upper tones.

The older horns and trumpets consisted of long conical brass tubes without valves of any kind. From such an instrument, it was only possible to elicit the harmonic upper tones of its fundamental, but as the principal tone of so long a tube is very deep, the upper tones in the middle of the scale would lie pretty near together, and most of the notes in the scale can be obtained. The trumpet was confined to these, such as they were, but in the trombone, by altering the length of the tube, the wanting notes can be supplied, and the faulty ones improved. Of late years valves have been used for a similar purpose, both in horns and trumpets, but at the cost of the power and quality of the tone. In using these instruments, the form and tension of the lips is only of importance to determine which of the harmonic sounds of the column of air is to be produced, the absolute pitch is quite independent of them.

In the human larynx, however, the tension of the vocal chords directly alters and determines the pitch. The hollow space of the mouth is not fitted to fulfil this duty. Its walls are too yielding to maintain a vibration of air sufficiently strong to carry with it the reed as in the trumpet or clarinet, moreover it is too short to have much influence on the pitch. Besides altering the tension of the chords, there is probably a power of weighting them with the moist unelastic tissue which lies immediately beneath them, so as to produce the lower notes of the chest voice.

The quality of the sound emitted by reeds unconnected with resonance tubes is very sharp and harsh, due to a long series of upper tones extending as high as the sixteenth or twentieth. The harder the material of the reed the greater the number of dissonant sounds produced, and it is probably due to the softness of the vocal chords that a good human voice is the pleasantest of all the reed instruments. Even in the voice we find very high upper tones, as high as the fourth octave. The resonance tubes modify the sound most essentially. They respond only to those sounds which are the proper tones of the tube. The clarinet, which must be regarded as a closed cylindrical pipe, gives only the upper tones of the uneven numbers, while the oboe, the tube of which is conical, gives those of the even numbers also. This is the cause of the difference in the quality of the sound of these two instruments, in both of which the sound is produced by the agency of a wooden reed.

So far we have considered the case of resonance tubes which are able to give the fundamental of the reed, and also a series of upper tones, but it may happen that the lowest tone of the resonance tube is not the fundamental of the reed, but one of its upper tones. Under these circumstances this particular upper tone will be prominently strengthened, and the sound will acquire a peculiar character resembling more or less the vowels of the human voice. In fact, the vowels are sounds produced by membranous reeds—the vocal chords, the resonance tube of which—the cavity of the mouth, can be so modified in width, length, and form as to fortify sometimes this, sometimes that, upper tone of the sound. The easiest and surest way of determining the proper tone which corresponds to the position of the mouth for each vowel is to gently whisper any vowel, retain the mouth fixed in that position, and test it by holding before it tuning-forks of various pitch until one is found, the sound of which is intensified by the resonance of the mouth. By passing in this way from one vowel to another, the tones peculiar to each position of the mouth may be ascertained. The determinations given below are those of Helmholtz, and apply to the vowels pronounced in the German way. Both for O and for U the opening of the mouth is narrowed by the lips, while the greatest possible space is given in the middle by drawing down the tongue, so that the mouth approximates to the form of a bottle with no neck. In such bottles the smaller the opening the lower the tone. This is borne out by these vowels. For U, in which the opening is the smallest and the space the largest, the proper tone is found to be f, and when the U is gradually converted into O by opening the mouth the resonance rises also, until for a pure O the proper tone of the mouth becomes b′ flat. The position of the mouth for O is particularly favourable for resonance, the opening being neither too large nor too small, and the hollows sufficiently large. If a fork which is tuned to b′ flat is struck and placed before the mouth while the vowel O is gently whispered, the sound of the fork becomes so full and loud that it can be heard by a large audience, but if the position of the mouth is now changed through Œ and Æ to A (as in father) the resonance rises a whole octave to b″-flat. The sharper English and Italian A rises to d″, that is, a third higher. For these vowels there appears to be only one peculiar tone, and the theory of sounds produced in spaces of this shape would not lead us to expect otherwise. Starting once more from A through the series A, Æ, E, I, we find that the lips are so far drawn back as not themselves to produce a narrowing, but that a narrowing of a different kind is effected by the front part of the tongue and the hard gums, while the space over the larynx is widened by drawing in the root of the tongue. The form of the mouth is now that of a bottle with a narrow neck produced by the upper surface of the tongue and the gum. For * I the hollow of the bottle is the largest, and the neck the smallest. For Æ the whole channel is rather wide. When these positions are tested two tones may be distinctly detected, the one corresponding to the large space, the other to the narrow tube-like passage between the gum and the tongue, so that the whole arrangement resembles in principle the organ pipes already described, in

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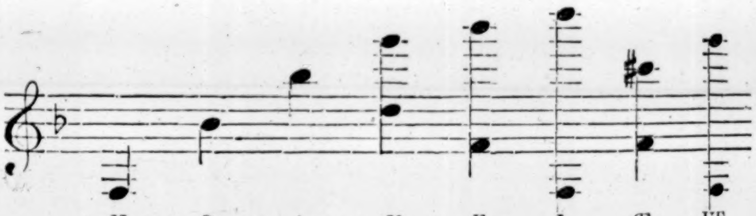
* I pronounced rather like the English E, and the E like a flat A.

which a small narrow tube is fixed into the closed top of the pipe. This condition is most prominent for I where the length of the small canal is about two inches. Such a pipe would give the sound c^{iv}. The tone really found to be produced is d^{iv}, which is pretty near the mark if we take into account the irregular form of the tube. These vowels, then, are distinguished by two tones, the higher of which continues the series of the vowels U, O, A. Helmholtz has found them to be for Æ, g''' ; and for E, b'''-flat ; and for I, d^{iv}. The lower tones, which are more difficult to determine, he found to be for Æ, d'' ; and for E, f' ; and for I, f. In producing the vowels Œ and UE the position is much the same as for the last, except that the lips come into play and lengthen as well as they can the small tube, thus lowering its pitch. For UE, its length will be about $2\frac{3}{4}$ inches, and the tone is found to be g'''. The lower tones are for Œ, f'; for UE, f. The following scheme exhibits the resonance of the mouth for each vowel :—



Hence we may conclude, and the supposition is borne out in practice, that certain vowels will sound better than others in particular parts of the scale, and they do so whenever their characteristic note is one of the harmonics of the note sung. U sounds in men's voices best on f, its characteristic note, or on d, or the lower octave F ; the vowel E best on f', or the harmonic under-tones f, or B, and so on. And this is particularly observable at or about the limits of the voice. Female voices have a tendency under c' to run into a dull O or OU, whose proper tone is situated here. In their higher note above e'' or f'', the vowel A sounds best, as its proper tone is at b''-flat and above b''-flat I.

From the foregoing considerations we may deduce the following principles :—

That what is called the quality of sound is an apparent rather than a real phenomenon.

That pure sounds, however produced, sound alike soft and pleasant, but dull and of little power.

That a difference in their quality is only produced when to the simple sounds are added one or more sounds of a higher or lower pitch ; and it is the mixture of simple sounds in various proportions that produces what is called the special quality of the sound emitted from different instruments.

That sounds which are accompanied by their lower upper tones about as far as the sixth are fuller and richer than simple sounds, but are still soft, provided the higher upper tones are wanting. Under this head we must class the pianoforte, the open organ pipes, the softer tones of the human voice, and the horn, which latter forms the link which connects these with instruments with high upper tones.

Flutes and the wide closed organ pipes approach nearly to the simple sounds.

That when only the upper tones of the uneven numbers are present, as in the narrow closed organ pipes, strings struck in the middle, and in the clarinet, the sound has a hollow, and if the upper tones are very numerous, a positively nasal character. When the fundamental is predominant the sound is full, but if it is deficient it is thin. On this account the sound of wide open pipes is fuller than that of narrow ones, and the sound of strings struck with a soft hammer, than those struck by a hard one, and the tone of reeds with a resonance tube richer than that of reeds not so furnished. When the upper tones beyond the sixteenth or seventeenth are perceptible the sound is sharp and rough, on account of the discord of the higher tones. The degree of sharpness may vary, if slight it does not prevent the use of such instruments in music. Under this head come fiddles, most reed pipes, the oboe, harmonium, and human voice. These dissonant upper tones are far more prominent in the brass instruments, and they can scarcely be used alone for classical music, but they are of value on certain occasions for their great power in the orchestra.

THE MAMMALS OF SOUTH AMERICA.

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(*With a Plate by Wolf.*)

THE Zoological differences between the Old and New Worlds have been well known to naturalists since the time of Buffon, whose theory it was that the animals of America were degraded descendants of those of the Eastern Hemisphere. While there is, no doubt, some sort of truth in this idea—for, where corresponding forms occur, the American is usually less in bulk and feebler in its distinctive characters than its representative in the Old World—it will be better, if we wish to gain a correct view of the Zoology of America, to dismiss altogether from our minds any idea of parallelism between the two Faunas. The northern portion of the Western Hemisphere is, it is true, overrun by Palæarctic forms, which have extended themselves southwards, in some cases even beyond the isthmus of Tehuantepec. But the great southern mass of the New World has been almost undisturbed by these northern invaders, and in every branch of Zoology—particularly among the Mammals—presents us with such a number of peculiar types, as to render the South American or Neotropical Region, after Australia, the most distinct of any of the great Zoological divisions of the world's surface.

In the present endeavour to put forward the general aspects of the Mammal-fauna of this region in a somewhat more decided light than has yet been attempted, I shall proceed to discuss the forms of the different orders of terrestrial Mammals that are found within its area, one by one. Summarizing the results thus arrived at, we shall not find it difficult to realize the principal characteristic features of Neotropical Zoology as regards this order of Vertebrates.

The American Monkeys, as universally allowed by Zoologists, form a strongly-marked division of the order Quadrumana, so distinct from the corresponding forms of the Eastern Hemisphere as not to be possibly confounded with them. They are spread over nearly the whole of tropical America, on the eastern side of the Andes, from the tierra caliente of Southern Mexico[*] to the most southern woodlands of Brazil and Uruguay. To the west of the Andes I am not aware that the presence of Quadrumana anywhere south of the Bay of Guyaquil has yet been recorded. The American Quadrumana are divisible into two well-marked sections, which perhaps deserve the rank of families. The Cebidæ, which are the most highly organized of the two divisions, are at once distinguishable from the Simiidæ of the corresponding latitudes of Africa and Asia by the presence of thirty-six teeth, instead of thirty-two; the false molars being increased from eight to twelve in number. The Marmosets (Hapalidæ), which take a lower rank, have the same total number of teeth as the Old World Simiidæ, but four fewer true molars, this difference being made up by a proportionate increase in the number of false molars—which, as in the Cebidæ, are twelve in number. The subjoined table will give at a glance the distribution of the generally-recognized families of the Quadrumana amongst the seven principal Zoological Regions of the earth's surface.

1. NEOTROPICAL REGION.	2. NEARCTIC REGION.	3. PALÆARCTIC REGION.	4. ÆTHIOPIAN REGION.	5.[†] LEMURIAN REGION.	6. INDIAN REGION.	7. AUSTRALIAN REGION.
Cebidæ Hapalidæ		Simiidæ	Simiidæ		Simiidæ	
			Lemuridæ	Lemuridæ	Lemuridæ Tarsiidæ	
				Chiromyidæ		

A few words may now be said concerning the principal genera which compose the two families of American Quadrumana. It may be remarked that the American Monkeys, are, without exception, exclusively *arboreal* in their habits. Some of the Old World members of the order, such as the Formosan Macaque (*Macacus cyclopis*, Swinhoe),[*] and the Barbary Ape (*Macacus Sylvanus*), are rather rock-climbers than tree-livers. But this is not the case with any species of the two American families of Quadrumana, as far as has been hitherto recorded. Commencing the series with these forms of the Cebidæ, wherein the possession of a fifth hand, in the shape of a prehensile tail, shows a more especial adaptation to tree-life, we first meet with the genera *Mycetes*,[†] *Lagothrix*, *Brachyteles*, and *Ateles*. In these forms the terminal vertebræ of the tail are dilated, and its extremity is denuded of hair on the under side, so as to permit of a firmer hold being taken by this organ, and to render it still more available for locomotion. Of the *Mycetæ*, or Howling Monkeys, so remarkable for the terrific bellowings which they are enabled to produce by a special modification of the hyoid bone and thyroid cartilage, about six species are generally recognized by naturalists. These range over nearly the whole of the limits within which the American Quadrumana are distributed, at any rate from Guatemala to Southern Brazil. *Lagothrix*, on the other hand, is a form confined to the valley of the Upper Amazon. Though several species of this genus have been described, it is probable that they may be all referable to varieties of the *Lagothrix Humboldtii*.[‡] The genus *Brachyteles* of Spix (= *Eriodes* of Isidore Geoffroy St. Hilaire) is another monotypic form, peculiar to the forests of S.E. Brazil. Although nearly allied to *Ateles*, it is distinguishable by "the peculiar position of the nostrils, the equality in size of the incisors, the shortness of the canines, and the globular form of the head."[§] *Ateles*, on the other hand, is more numerous in species, and more widely diffused, the most northern monkey hitherto recorded in the New World belonging to this genus,[‖] and the group being represented also in Southern Brazil. About seven or eight species of *Ateles* appear to rest on good authority, and are usually recognized. They are all remarkable for their long slender bodies and elongated limbs, whence they have obtained the appropriate name of Spider Monkeys. They are also distinguishable by the absence or imperfection of the thumb, a structure which, singularly enough, likewise occurs in a genus of Simiidæ (*Colobus*) met with in the corresponding latitudes of the African continent.

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[*] For some remarks on the northern limit of the Quadrumana in the New World, see 'Nat. Hist. Rev.,' 1861, p. 507, where I have endeavoured to show where the line should be drawn with more exactitude than has hitherto been done.

[†] I have hitherto only reckoned the principal Zoological Regions of the earth, as *six* in number, having associated Madagascar and its islands with Africa. The peculiarities of the Zoology of Madagascar and the Mascarene Islands are, however, so great, especially as regards its Mammals (see my former article on this subject, 'Journ. of Sc.,' vol. i. p. 213), that it is perhaps better to consider them as forming a distinct Zoological Region, for which no term can be more appropriate than that of *Lemuria*, as has been already suggested *l. c.*

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[*] 'Proc. Zool. Soc.,' 1812, p. 350.

[†] *Mycetes* is usually arranged in this neighbourhood, but Mr. Flower has recently shown ('P. Z. S.,' 1864, p. 338) that, as regards its brain-structure, it departs widely from *Cebus* and the more highly-organized Platyrhines, and appears to be more closely allied to *Nyctopithecus*. The structure of its sternum is also abnormal.

[‡] Cf. Bates' 'Naturalist on the Amazon,' ii. p. 319; and Slack in 'Journ. Acad. Phil.,' 1862, p. 515.

[§] Slack, 'Proc. Acad. Phil.,' 1862, p. 513.

[‖] See 'Nat. Hist. Rev.,' 1861, p. 508.

Next to these four genera we must arrange the typical form *Cebus*, in which the tail, though still prehensile and having the terminal vertebræ dilated, is wholly covered with hair, and does not serve the same important office of a fifth hand, as is the case in the Ateline groups. The *Cebi* have a wide range, from Guatemala on the north, to the banks of the Uruguay in the south. They are very difficult to distinguish specifically, owing to their great variation in colouring. Wagner, in his supplemental volume to Schreber's Säugethiere, reduces the species of this genus to ten, while Reichenbach, in his lately published Natural History of Apes,* recognizes not less than thirty-five! There can be no doubt that of the two Wagner is much nearest to the mark.

After *Cebus* we come to a section in which the tail is lax and villous throughout, and no longer used for prehension. This group embraces the insect-eating genera *Nyctipithecus*, *Callithrix*, and *Chrysothrix*. *Nyctipithecus* contains some three or four species from the great wood region of the interior of South America, remarkable for their owl-like physiognomy and nocturnal habits. *Callithrix* is a more numerous genus, and rather wider in its distribution, *Callithrix personata* being said to occur on the banks of the river Parana, north of Corrientes, and two or three other species, besides this, being found in South-eastern Brazil. *Chrysothrix* embraces three species, two from the Amazon valley, and a third (*C. sciurea*) from Guiana and Venezuela, but extending up the Panamanic Isthmus as far north as David.†

All the preceding genera of American Quadrumana have vertical incisors like the Monkeys of the Old World. There remain to be noticed two forms belonging to the Cebidæ, peculiar for having their incisors sloping forward like some of the Lemuridæ. These are *Pithecia* and *Brachyurus*. The Sakis (*Pithecia*) number some seven or eight species, which inhabit various parts of the great Amazonian wood region and Guiana. *Brachyurus*, distinguished from *Pithecia* by its abbreviated tail, contains four species, all from the forests of Amazonia.

The second family of the American Quadrumana, the Hapalidæ (Marmosets), comprehends about thirty species, divisible into two genera, *Hapale* and *Midas*. They are most numerous in the forests of the interior of South America, ranging as far south as the borders of the Argentine Republic. One species (*Hapale œdipus*) is common in Chiriqui, Central America, but I am not aware that any member of this family has been known to occur farther north.

In considering the Neotropical forms of the next great order of Mammals, the Chiroptera, I shall follow strictly the new classification of this group lately proposed by my friend Dr. Peters, of Berlin,‡ who has devoted so much time and attention to the study of this difficult order. Dr. Peters divides the Chiroptera into seven families, of which the subjoined table shows the geographical distribution:—*

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* Die Vollständigste Naturgeschichte der Affen. Dresden.

† See 'Proc. Zool. Soc.,' 1856, p. 139.

‡ 'Sitzungsb. Ak. Wiss. Berl.,' 1864, p. 256.

1. Neotropical Region.	2. Nearctic Region.	3. Palæarctic Region.	4. Æthiopian Region.	5. Lemurian Region.	6. Indian Region.	7. Australian Region.
			Pteropodidæ	Pteropodidæ	Pteropodidæ	Pteropodidæ
			Megadermatidæ		Megadermatidæ	Megadermatidæ
		Rhinolophidæ	Rhinolophidæ	Rhinolophidæ	Rhinolophidæ	Rhinolophidæ
Phyllostomatidæ	Phyllostomatidæ					
Noctilionidæ			Noctilionidæ		Noctilionidæ	Noctilionidæ
Molossidæ		Molossidæ	Molossidæ	Molossidæ	Molossidæ	Molossidæ
Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ

It will be observed that the true frugivorous bats, forming the family Pterpodidæ, which on account of their three-jointed index-finger and peculiar dentition are often regarded as constituting a separate sub-order of the Chiroptera, are altogether wanting in the New World, their place in the economy of nature being taken by certain forms of the more typical Chiroptera, the structure of which is so modified as to enable them to perform the same functions. So, likewise, are the two first families of the Insectivorous section. In the third family the Phyllostomatidæ, or Vampires, we have a group purely American, and, indeed, forming one of the most characteristic features of the Neotropical Fauna, as they are nearly entirely confined to the Neotropical area, only one or two species wandering beyond its limits into the neighbouring parts of the northern region of the New World.

The Phyllostomatidæ form one of the three families of Insectivorous Bats which are provided with a peculiar dermal development on the upper surface of the nose. From the Leaf-nosed Bats of the Old World (Megadermatidæ and Rhinolophidæ) the Phyllostomatidæ are at once distinguishable by having *three*, instead of *two*, bony phalanges in the middle finger. With the exception of the genus *Macrotus* the ears generally stand asunder from one another, as in our Horseshoe Bats (*Rhinolophus*), but they are always provided with an "ear-clapper" or tragus, placed in front of the aural orifice, which is wanting in the *Rhinolophi*. They are divided by Dr. Peters into five sub-families, concerning which we may say a few words.

The typical Phyllostomatidæ or *Vampyri* of Dr. Peters contain the genera *Phyllostoma*, *Vampyrus*, *Carollia*, and *Macrotus*. They are insectivorous, although the large *Vampyrus spectrum* has been stated, upon what is apparently good evidence, to be addicted to blood-sucking, like the true Desmodinæ. The second sub-family (Glossophagina), comprehending genera with an elongated snout and a long producible and sharp-pointed tongue, is also insectivorous. The next sub-family (Stenodermatina) contains only frugivorous bats, much like the Vampires in external appearance, but with teeth-characters modified to suit their diet. The fourth sub-family, as arranged by Dr. Peters, contains only the two very peculiar genera *Desmodus* and *Diphylla*, wherein the teeth are expressly modified into an instrument for tapping the blood of other Mammals. In the young *Desmodus* six upper incisors are present; in the adult animal the two outer pairs disappear to make room for the highly-developed medial pair, the inner margins of which meet together and form a most formidable weapon for blood-letting. True molars are wanting altogether in this form of bats, as they have no occasion to masticate their food. The stomach of *Desmodus* also presents a most remarkable structure, which has lately been described by Professor Huxley,* and is clearly connected with its abnormal diet. The cardiac end of this organ assumes the form of an elongated cæcum reflexed upon itself, and is evidently intended to form a reservoir for the blood drained by the *Desmodus* from the body of its victim.

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* In accordance with the convenient (though not strictly classical) system generally adopted in this country, I have so far modified Dr. Peters' family names as to bring them all to a uniform termination in *idæ*.

Whatever may be the case with regard to the other Vampires, we have the most unquestionable evidence as to the blood-sucking habits of the genus *Desmodus*, Mr. Darwin having been present when, in the neighbourhood of Coquimbo, in Chili, one of his servants captured a bat of this form actually fastened upon a horse's back. As regards its ally *Diphylla*, we have similar testimony from Mr. Fraser, who sent home from Ecuador an example of *D. ecaudata* taken in the act of sucking blood from a man.† The fifth and last sub-family of the Phyllostomatidæ consists of *Mormops*, *Chilonycteris*, and the allied form *Pteronotus*, three genera of which the principal sedes is the West Indian Islands, although some of the species penetrate into the adjoining parts of the continent. They are remarkable for having the end of the tail free, and extended from the back of the caudal membrane.

We now come to the Insectivorous Bats, without any foliaceous appendage to the nose. These are divided by Dr. Peters into three families, each of which has three representatives in South America. Of the Brachyura or Noctilionidæ, as we should prefer to call them, distinguished by the abbreviated tail, which is shorter than the anal membranes, four well-marked genera are met with in this region. The most remarkable of them, and one of the most curious forms in the whole series of Chiroptera, is *Diclidurus*, in which the terminal caudal vertebræ are so modified as somewhat to resemble a bell. The single known species of this form, which is of rare occurrence, has been obtained in Brazil and in Central America. It is, moreover, remarkable for the colour of its fur, which is nearly white—a most unusual character amongst the Mammals of tropical regions.

The Molossidæ, with their long rat-like tails and swollen lips, are represented in America by species of the genera *Molossus* and *Nyctinomus*, the former, as restricted by Dr. Peters, being peculiar to the tropics of America. The typical and very numerous family, Vespertilionidæ, is of universal distribution, but presents us with several purely Neotropical forms, such as *Histiotus*, *Natalus*, and *Thyroptera*.

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* "On the Structure of the Stomach in *Desmodus rufus*." By Professor T. H. Huxley. 'Proc. Zool. Soc.,' 1865, p. 386.

† See 'Proc. Zool. Soc.,' 1860, p. 212.

The third great order of Mammals, the Insectivora, are, as far as our present knowledge extends, entirely wanting over the whole of the continental portion of America south of Panama. The Arctopolitan* genus *Sorex* descends into Central America as far south as Guatemala, where a single species was collected by Mr. Salvin.† Other Shrews are registered in Dr. Gray's Catalogue of the Mammals in the British Museum as having been obtained at Coban, in the same country. But farther south every trace of the Insectivora disappears, and their place in the economy of nature is probably supplied by the entomophagous Marmosets, and by the numerous small species of Marsupials belonging to the family Didelphyidæ, some of which present a remarkable similarity to the true Insectivora.‡

In the West Indian Islands, however, which certainly belong to the Neotropical region, we meet with a single very anomalous and isolated form of Insectivores—the genus *Solenodon* of Brandt. Two species are now recognized of this extraordinary type, inhabiting different islands. The *Solenodon paradoxus*, made known to science by Professor Brandt, of St. Petersburg, as long ago as 1833, is from Hayti. The *Solenodon cubanus*, lately described by Dr. W. Peters in an elaborate Memoir in the Transactions of the Royal Academy of Sciences of Berlin, is, as its name indicates, from Cuba. The *Solenodon*, we may remark, had been previously noted as occurring in Cuba by Señor F. Poey, of Havana, who has done so much towards the investigation of the Fauna of that island, but had not been distinguished from its Haytian representative, until Dr. Peters came to compare the two animals together.

The great order of flesh-eaters, or Carnivora, which we now arrive at, is spread over the whole earth, with the exception of Australia, where, as has already been shown, its place is supplied by Marsupial forms modified to serve the same purpose. In South America, representatives of four of the families into which the Carnivora are usually divided are met with, namely, Felidæ, Canidæ, Mustelidæ, and Ursidæ. The Hyenas (Hyænidæ), which are usually recognized as a separate family, and the Civets (Viverridæ) are entirely restricted to the Old World, with the exception of the single Mexican genus *Bassaris*, which is commonly assigned to the latter family. We will commence our survey of the Neotropical Carnivora with the Digitigrade section, which embraces the three families Felidæ, Canidæ, and Mustelidæ.

Of the first of these families, all the South American representatives belong to the typical genus *Felis*. They may, however, be divided into two sections: first, the striped and spotted Cats, headed by the Jaguar (*Felis onca*); and secondly, the uniformly-coloured species, of which the best-known example is the Puma (*Felis concolor*). The Jaguar is the largest and finest species of the Cat-group in the New World, and indeed yields only to the Tiger and Lion of the whole Feline family in strength and power. Besides the conspicuous differences of its markings, it is distinguishable from the Leopards of the Old World by its thick and compact form. The Jaguar has a wide range in America. In La Plata it is found in the eastern region, in the woods along the banks of the larger rivers. Throughout Brazil and Guiana it is also generally distributed, and according to Tschudi is met with in both the eastern and western Peru. It extends throughout Central America and Mexico, and into the United States as far north as the Red River of Louisiana.* In the grassy Llanos of Venezuela the Jaguar is said to be very abundant, the introduction of European cattle and horses having enabled these large beasts of prey to find subsistence in a region where, in its original state, they would have found much difficulty in obtaining a sufficient supply. The other South American Cats belonging to the "striped and spotted" section are mostly of comparatively small size. In the Pampas of La Plata the long-haired *Felis payeros* is the characteristic species, and extends all over the great plains which compose the eastern portion of this part of South America, going nearly as far south, according to Mr. Darwin, as the Straits of Magellan. In the coast-forests of South-eastern Brazil, *Felis mitis* and *F. macrura* occur; in the great Amazon valley, *F. tigrina*, *F. celidogaster*, and *F. pardalis* are met with. The latter species, under the form of one or more of several barely-distinguishable varieties, ranges all through Central America and Mexico into Texas. The uniformly-coloured Cats, which are further distinguished by the round pupil of the eye, are headed by the Puma, or "American Lion," as it is often called. The Puma has a still more extensive range in America than the Jaguar, or perhaps than any other species of Mammal. From Chili and Patagonia on the south, it appears to be distributed all over the southern and northern continents up to 50° or 60° N.L., thus presenting us with a range of some 110° of latitude. The Eyra (*Felis eyra*) and the Jaguarundi (*Felis yagouaroundi*), which belong likewise to the unspotted section, seem to accompany the Puma in its wanderings to a certain distance, being included by Burmeister among the Mammals of South-eastern Brazil, and by Baird amongst those of Texas. They are, therefore, doubtless also found in intermediate localities, although their exact range has not been yet well worked out.

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* I call those genera "Arctopolitan" which are common to the northern regions of the two hemispheres, such as *Arctomys*, *Bison*, *Castor*, &c. Such forms as are common to the tropical regions (such as the Trogonidæ) may in like manner be called "Tropicopolitan."

† *Sorex micrurus*, Tomes, 'P. Z. S.,' 1861, p. 279.

‡ Especially the genus *Hyracodon*, Tomes, 'P. Z. S.,' 1863, p. 50.

So much for the Felidæ of South America. We must now say a few words about the Canidæ of the same country, which comprehend two well-marked types, *Icticyon* and *Canis*. Of these *Icticyon* embraces only a single peculiar species, first made known to science by Dr. Lund, in 1841. The *Icticyon venaticus*, or Cachorro di Mato of the Brazilians, has sometimes been referred to the Mustelidæ. But there is now no doubt, as Professor Burmeister (who formerly adopted this view) has himself shown,* that its proper place is with the Dogs (Canidæ), of which it is an aberrant form, resembling the Badgers (*Meles*) in habits, as in certain parts of its structure.

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* Dr. Gray has described the Mexican Jaguar as distinct (*Leopardus hernandezi*, 'Proc. Zool. Soc.,' 1857, p. 278, pl. 58), but as a separate *species* I think it requires confirmation, being based merely on differences of coloration, which in the whole Feline group is very variable.

To Professor Burmeister we are also indebted for a very elaborate account of the American species of *Canis*.† These are seven in number, and are divisible into three sub-genera, which Professor Burmeister calls *Chrysocyon*, *Lycalopex*, and *Pseudolopex*. The first contains only the peculiar *Canis jubatus* of Desmarest, distinguished by its large size and brilliant colouring, which is found chiefly in the swampy and more open districts of Southern Brazil and the Argentine Republic. The second (*Lycalopex*) embraces three species: *C. cancrivorus*, of the wooded districts of Western South America, and *Canis vetulus* and *C. fulvicaudus*, of the Campos of Inner Brazil. The third (*Lycalopex*) contains three species; the best known of which is the *Canis azaræ*, which is very abundant all over the southern extremity of the American continent. Mr. Darwin tells us that this animal is "common in La Plata, Chili, and the whole of Patagonia, even to the shores of the Strait of Magellan." In the sterile and deserted regions of these countries this dog often prowls about by daytime, preying chiefly on the smaller Rodents. In Chili it is said to be very destructive in the vineyards from the quantities of grapes which it consumes, and necessitates the presence of watchers to keep it away. The *Canis magellanicus*, which is also a *Lycalopex*, seems to be confined to the western side of the Andean chain, ranging from "the humid and entangled forests of Tierra del Fuego to the almost absolutely desert country of Northern Chili." ‡

The Mustelidæ—a well-defined group of Carnivores, easily recognized by the presence of only a single tubercular molar in each jaw—are by no means abundant in South America, the greater number of the species being restricted to the more temperate regions of both hemispheres. There, nevertheless, occur within the limits of the Neotropical Region representatives of several genera belonging to this group to which we must call our readers' attention. Of the more typical Mustelidæ I am not aware that more than one species is certainly known as occurring in South America—the *Mustela frenata* of Lichtenstein, which may have probably extended itself southward from its original sedes in Mexico,§ along the Andean range.

In *Galictis*, on the other hand, we meet with a purely Neotropical form represented by two species, both belonging to Brazil and the adjoining countries of South America, but not, as far as I know, found to the north of the Isthmus of Panama. *Mustela* and *Galictis* are the only two forms of Neotropical Mustelinæ. Of the Otters (*Lutrinæ*), which form a second well-marked division of the same family, distinguished by their aquatic habits no less than by their peculiar structure, several distinct species occur in South America. In Chili the *Lutra chilensis* is "exceedingly common among the numerous islands and bays which form the Chonos Archipelago." This otter by no means confines itself to fish, having been observed by Mr. Darwin to prey on volutes, cuttle-fish, and crabs. In Brazil the *Lutra brasiliensis* inhabits the river banks after the manner of our well-known European species.

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* Erläuterungen z. Fauna Brasiliens, p. 1.

† Op. cit., p. 19 et seq.

‡ Darwin, in Zool. Voy. 'Beagle,' ii. p. 11.

§ *Mustela aureiventris* (Gray, 'P.Z.S.,' 1864, p. 55), from Ecuador, is probably the young of this species. *M. agilis* of Tschudi's Fauna Peruana is perhaps not different.

The sub-family Melinæ, typified by our European Badger, includes the Skunks of the New World (*Mephitis*), so notorious for the suffocating odour which they produce when irritated, which have one or more representatives in South America, although the more typical species of the genus are found only in Middle and Northern America. The *Mephitis patagonica* is found over La Plata, Patagonia, and Chili; and other species have been described from various parts of Southern and Central America. The Southern forms all belong to the subgenus *Thiosmus* of Lichtenstein, but it seems doubtful whether they are anything more than varieties of one variable species.

The plantigrade Melinæ form the transition to the last family of Carnivora, the Ursidæ or Bears, which are essentially distinguished from the other groups of the same Order by their peculiar dentition. Of the typical genus, *Ursus*, only one species is generally acknowledged as South American—the Spectacled Bear (*Ursus ornatus*) of the higher Peruvian Andes. Tschudi has described a second (*Ursus frugilegus*), from the warmer zone of the same country, but I am not aware that specimens of this species exist in any European collection. Besides the Bears, however, three other genera belonging to the same family are found in South America—the Raccoons (*Procyon*), the Coatis (*Nasua*), and the Kinkajous (*Cercoleptes*). The South American Raccoon (*Procyon cancrivorus*) is a well-marked species, belonging to the same genus as the well-known Raccoon of the United States (*P. lotor*). It appears to be common in the forests of Brazil and Guiana. The Coatis (*Nasua*), distinguishable by their long tail and produced movable snout, have a wider range, from Mexico southward to La Plata. Many species have been described of this genus, but it still remains doubtful whether there exists more than one variable species. The Kinkajou (*Cercoleptes*) is still farther aberrant from the typical Bears than either of the two last-named genera, and is sometimes considered as the type of a distinct family. It may be regarded as a characteristic form of Neotropical Mammals, being restricted to the wood regions of the Amazon valley and countries northwards as far as Guatemala. Only one species of this peculiar, prehensile-tailed, nocturnal Mammal-form is known to science.

The subjoined table will show at a glance the principal forms of Neotropical Carnivora, the names of those restricted to the Neotropical

Region, and therefore especially characteristic of this Fauna, being printed in italics:—

CANIDÆ.	FELIDÆ.	MUSTELIDÆ.	URSIDÆ.
Icticyon	Felis	Mustela	Ursus
Canis		*Galictis.*	Procyon
		Lutra	*Nasua*
		Mephitis	*Cercoleptes*

The Rodentia, which now claim our attention, in South America, as in nearly every other part of the world, are more numerous in species, and more abundant in individuals, than any other order of Mammals. A considerable number of genera belonging to this group are also peculiar to the Neotropical Region, especially, as we shall see, among the Hystricine forms, which are very extensively developed in this part of the world. In attempting to give an outline of the more noticeable features of this difficult group, I shall base my remarks principally upon Mr. Waterhouse's paper on the distribution of this Order, given in the Zoological Society's 'Proceedings' for 1839, and in the same author's volume on the Leporidæ and Hystricidæ in his excellent (but, alas! unfinished) 'History of Mammals.' In the above-named paper of Mr. Waterhouse, the Rodentia are divided into eight families. In the tables subsequently given in Keith Johnston's 'Physical Atlas' only four of these are adopted, namely—Sciuridæ, Muridæ, Hystricidæ, and Leporidæ. To these I agree with Professor Baird in adding, as a distinct family, the Saccomyidæ or Pouched Rats, distinguished by their large and distinct external cheek-pouches, a group peculiar to, and very characteristic of, the Northern Region of the New World, which may be intercalated between the Muridæ and Sciuridæ.

The Sciuridæ, which must be placed at the head of the Rodentia, are by no means abundant in South America. Of five well-marked genera—*Sciurus*, *Pteromys*, *Tamias*, *Spermophilus*, and *Arctomys*, commonly referred to this family, but one—typical *Sciurus*—occurs at all within the limits of the Neotropical Region. And of *Sciurus*, out of some sixty or seventy known species, seven or eight only are South American. In S.E. Brazil the only species mentioned by Burmeister are *Sciurus langsdorfii* of the interior and *S. æstuans*, which is common all along the forests of the eastern coast. The latter Squirrel is alone attributed to Guiana by Schomburgk. In Eastern Peru, besides this two others occur, according to Tschudi, and a fourth (*Sciurus stramineus*) has been obtained from the western coast-region of the same country. In the Amazon Valley several others are met with, specimens of which were first obtained by the indefatigable collector Johann Natterer. No squirrel is given by Rengger or Azara as occurring in Paraguay, so that we may take the southern limits of this form as terminating with the forest region of Brazil. In Central America, on the other hand, as we go north, the species become more numerous, four *Sciuri* having been obtained in Guatemala by Mr. Salvin, and several others occurring in Southern Mexico.

The Muridæ are, on the contrary, very numerous in South America, as in most other countries, but belong to a different section of the family from the typical *Mures* of the Old World. They have been constituted a particular tribe or sub-family by Burmeister, under the name *Sigmodontes*, from the peculiar structure of the molar teeth, by which they are readily distinguishable from their representatives in the Eastern hemisphere. The best-marked South American genera included in this section are *Hesperomys*, *Rithrodon*, and *Holochilomys*. *Hesperomys* and its subdivisions embrace some forty species, generally diffused over South America. *Rithrodon* embraces three species, all from La Plata and the southern extremity of the continent. *Holochilomys* has four Brazilian species. Other less known genera of this group are *Acodon* and *Drymomys*, founded on single species from Peru. I should mention that the common European species of true *Mus* are likewise firmly established in many parts of South America, but doubtless owe their introduction to the agency of man.

We now come to the Hystricidæ, which, as I have already said, is essentially a South American group. Mr. Waterhouse divides this family into six minor sections or sub-families, *viz.* Hystricina, Dasyproctina, Echimyina, Octodontina, Chincillina, and Cavina. Of these the true porcupines (*Hystricina*) are alone widely distributed, the two typical genera of this group, *Hystrix* and *Atherura*, being found in the Old World. The five remaining sub-families, if we except the two African types *Aulacodus* and *Petromys*, are entirely restricted to the Neotropical Region. We must devote a few remarks to each of these groups.

The Cavies (*Cavina*) embrace three well-marked forms, all restricted to South America—*Dolichotis*, *Cavia*, and *Hydrochærus*. *Dolichotis* contains only the hare-like Patagonian Cavy (*D. Patachonica*), which forms one of the characteristic features of the Patagonian landscape, being common all over the gravelly deserts of that country. *Cavia* is known by some seven or eight representatives, mostly Brazilian, but in one instance extending far southwards down to the Magellan Straits. Our domestic "Guinea pig" is derived from one of these species, a native of the banks of the Rio de la Plata. The Capybara (*Hydrochærus*), the largest known species of Rodent, is also abundant in the vicinity of the same river, though it extends far northward over all Brazil into Peru and Guiana. It is generally stated to be the favourite prey of the jaguar. The Chincillas, which from the second sub-family of Mr. Waterhouse's arrangement, are chiefly found in the mountainous districts of Peru and Chili, though one species (the Viscacha) is confined to the plains of La Plata, and forms a very prominent feature in the Zoology of the Pampas. The Alpine Chinchillas (*Lagidium* and *Chinchilla*), so remarkable for their soft and delicate fur, which caused them to be known commercially long before we became acquainted with their curious structure, are distributed over the Andes of Chili, Bolivia, and Peru, and range up to an altitude of 12,000 feet above the sea-level. The third sub-family (Octodontina) is again exclusively South American, embracing about a dozen species referable to the genera

Habrocoma, *Octodon*, *Schizodon*, *Spalacomys*, and *Ctenomys*, which inhabit the middle and southern parts of that continent, occurring on both sides of the Andean range. They are all of small size, and are partly of burrowing, partly of more or less climbing, habits, agreeing with the Cavies and Chinchillas in having rootless molars, but readily distinguishable from these two families by the possession of five well-developed toes on the hind feet. The *Spalacomys poeppigii* presents a curious deviation in mode of life from the rest of the group in living nearly entirely under ground, and only occasionally emerging at night-fall. In the next sub-family (the Echimyina) we meet with two African types, *Petromys* and *Aulacodus*. The remaining genera, *Capromys*, *Myopotamus*, *Cercomys*, *Dactylomys*, *Loncheres*, and *Echimys*, are all exclusively Neotropical types. *Capromys* and *Plagiodus* are characteristic forms of the Antilles. The other genera inhabit the northern and central portions of the continent, not, however, as far as I know, occurring northwards of the Isthmus of Panama. The best known animal of this section is, perhaps, the water-loving Coypu (*Myopotamus coypus*), which has much superficial resemblance to the Beaver (*Castor*), and has been erroneously associated with that animal. The Agoutis (Dasyproctina) form the fifth subdivision of the great Hystricine family according to Mr. Waterhouse's system. They embrace two genera, *Cœlogenys* and *Dasyprocta*, both exclusively Neotropical. The first-named genus contains but one well-established species, the Paca, *Cœlogenys paca*. Nothing can give a better idea of the poverty of large animals useful for food in the Amazonian forests, than the fact that this little animal and the Coypu are the species most sought after for food by the hungry hunter, who, in a corresponding latitude in Africa would be feeding on the flesh of elands and giraffes. The Agoutis (*Dasyprocta*) are nine or ten in number, extending from Paraguay and Bolivia into Mexico.* This is also one of the few genera of Mammals (exclusive of Bats) which occur in the West Indian Islands. Lastly, we come to the sixth sub-family, Hystricina, of which the most typical forms, *Hystrix* and *Atherura*, are peculiar to the Old World. The American Porcupines form, in fact, quite a separate section of the group to which Professor Brandt has given the name "Philodendreæ," from their tree-loving habits. They are divisible into three genera, *Erethizon*, *Cercolabes*, and *Chætomys*. The first of these is a Nearctic† form, the remaining two are Neotropical. *Chætomys* contains but a single Brazilian species; *Cercolabes* comprehends a series of a dozen species or so, which are diffused all over the forests of America from Mexico to Paraguay.

The last family of Rodents, the Hares (Leporidæ), contain only two generic forms, *Lepus* and *Lagomys*. The latter is an Arctopolitan type, being confined to the Palæarctic and Nearctic regions. *Lepus* is thinly diffused over the greater part of the world, except the Australian region, but appears especially prevalent in North America, where some twelve or thirteen species are known to occur. In South America a single species of Hare only is found—the *Lepus brasiliensis*, which extends over Brazil and the adjoining parts of Peru, Bolivia, and Paraguay. With this species is concluded the long series of Neotropical Rodents.

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* M. de Saussure has lately described a Mexican species, *D. Mexicana*. 'Rev. Zool.,' 1860, p. 53.

† Dr. Gray has recently described a species of *Erethizon* from New Granada (*E. rufescens*, 'P. Z. S.,' 1865, p. 321), but I doubt its truly belonging to this genus; and Dr. Gray has provided a sub-genus for its reception (*Echinoprocta*).

The next succeeding orders of Mammals contain all the largest and most bulky animals at present existing on the earth's surface. In considering them we shall at once see the poverty of the Neotropical region in these forms of animal life as compared with the corresponding parts of the Old World. While Asia and Africa have each their species of Elephant, no Proboscidean is known to the existing Fauna of the New World. While four types of Perissodactyles are found in various parts of the Eastern Hemisphere, the Western World numbers only one of these forms in its existing Fauna. Among the Artiodactyles of the Neotropical regions we look in vain for anything corresponding to the *Hippopotami* and Wart-hogs of Africa. The non-ruminant division of this Order is only represented in America by two species of the peculiar genus *Dicotyles*. When we come to the Ruminating Artiodactyles, the contrast is still greater. Where in South America can we find anything to compare to the 70 or 80 species of Antelopes and other Bovidæ of the Indian and African Faunas? This great family, the most useful of all to mankind, is absolutely without a single representative in the whole of the Neotropical region. Throughout the greater part of the immense area of South and Middle America the only Ruminants to be met with are some scattered species of Deer (*Cervus*)—the second and only peculiar Neotropical form of the Ruminants being confined to the elevated regions of the Bolivian and Peruvian Andes. The following table shows the general distribution of the Ungulata:—

Distribution of the Ungulata.

1. NEOTROPICAL REGION.	2. NEARCTIC REGION.	3. PALÆARCTIC REGION.	4. ÆTHIOPIAN REGION.	5. LEMURIAN REGION.	6. INDIAN REGION.	7. AUSTRALIAN REGION.
		Equidæ	Equidæ		Equidæ	
Tapiridæ					Tapiridæ	
			Hyracidæ			
			Rhinocerotidæ		Rhinocerotidæ	
			Hippopotamidæ			
Suidæ			Suidæ		Suidæ	
			Tragulidæ		Tragulidæ	
		Moschidæ				
Cervidæ	Cervidæ	Cervidæ			Cervidæ	
			Camelopardalidæ			
Camelidæ		Camelidæ			Camelidæ	
	Bovidæ	Bovidæ	Bovidæ		Bovidæ	

I must add a few words on the special distribution of each of the four Neotropical representatives of the Ungulata.

The Tapiridæ of South America are two in number: the common and well-known *Tapirus americanus*, which is found all over the wood regions of Central and Southern America, and the Hairy Tapir (*T. villosus*), a little-known species peculiar to the Peruvian Andes, of which, I believe, there is no specimen in any museum in this country.

Of Suidæ, as I have already said, the Neotropical region possesses but a single form, the Peccary (*Dicotyles*). The two known species of this form appear to be widely diffused from Guatemala throughout Central and Southern America to Paraguay, wherever suitable localities exist. The Collared Peccary (*D. torquatus*) ranges farther northward than the white-lipped species, occurring even in the plains of Texas.

The Cervidæ of the Neotropical region are some nine or ten in number, pretty generally distributed throughout the whole area, except in the extreme South. They are all, however, referable to the less typical forms of the group—true *Cervus* only occurring in the Palæarctic and Nearctic Regions. *Furcifer*, *Blastocerus*, and *Coassus* are the sub-generic names of the Neotropical forms of this family.

Lastly, the Camelidæ of the Old World are represented in the Bolivian and Peruvian Andes by the genus *Auchenia*, of which there are usually held to be two distinct wild species, the Guanaco (*A. guanaco*) and the Vicugna (*A. vicunia*), the Lama and Alpaca being generally considered to be domestic varieties derived from their stocks respectively.

The next following Order of Mammals—the Edentata of Cuvier—forms one of the most characteristic features of Neotropical Zoology. Of the two great divisions which make up the Order, one—the Phyllophagous section, comprehending the single family of Sloths (Bradypodidæ)—is wholly peculiar to this region. Of the second or Entomophagous division, two families, which contain the greater number of the species, are likewise restricted to South America—leaving only two types (*Orycteropus* and *Manis*) represented throughout the whole of the Eastern Hemisphere.

The subjoined table will show at a glance the general distribution of the whole Order Edentata over the earth's surface:—

1. NEOTROPICAL REGION.	2. NEARCTIC REGION.	3. PALÆARCTIC REGION.	4. ÆTHIOPIAN REGION.	5. LEMURIAN REGION.	6. INDIAN REGION.	7. AUSTRALIAN REGION.
Bradypodidæ Dasypodidæ Myrmecophagidæ			Manididæ Orycteropodidæ		Manididæ	

The leaf-eating Sloths forming the family Bradypodidæ are quite as extraordinary in their habits as in their organization, and certainly constitute one of the most *outré* groups in the whole class of Mammals. Being so exclusively arboreal as, in a state of nature, never, perhaps, to touch the ground during the whole period of their existence, the Sloths are necessarily confined to the densely-wooded districts of Southern and Central America, and in conjunction with other arboreal types, seem to indicate that these vast forests must have existed in a state not very different from their present condition during a vast period. The most northern locality hitherto recorded for any member of this group is Costa Rica, whence Dr. Peters has lately received several examples of a new and very interesting species of the two-toed genus *Cholœpus*.* Thence they extend southwards over the great wood region of Brazil and Peru to the frontiers of Paraguay and La Plata. About six species of *Bradypus* and two of the genus *Cholœpus* have been recognized by naturalists, but several of the former require further elucidation.

The Entomophagous Edentates of America consist of two very distinct families, the Armadillos (Dasypodidæ) and the Anteaters (Myrmecophagidæ). The former is rather a numerous group, some twenty species being known to science. A single Armadillo (*Dasypus peba* var. *mexicana*, Peters) occurs as far north as Texas. Hence descending southwards, the form is diffused all over the Continent down to Patagonia. In the Argentine Republic Dr. Burmeister records the presence of five species. The more typical section of this family (Dasypodinæ) is divisible into several genera. A second sub-family (Chlamydophorinæ) contains only the very remarkable form *Chlamydophorus*, of which the species originally described, and long considered as the only existing representative of this most extraordinary form, is exclusively confined to the vicinity of Mendoza in the Argentine Republic. A second species recently described by Dr. Burmeister (*C. retusus*) is from the province of S^ta^ Cruz de la Sierra, in Bolivia. The Anteaters (Myrmecophagidæ), very distinguishable from the Armadillos by their extensile tongue, wholly toothless jaws, and hairy covering, are not so numerous in species. Of the largest and only terrestrial form *Myrmecophaga*, one species only is known to exist. Of each of the two arboreal genera with prehensile tails (*Tamandua* and *Cyclothurus*) two species have been described. Both these forms extend to the north of the Panamanic Isthmus, the former into Southern Mexico,† and the latter as far as Costa Rica, whence a second species has recently been described by Dr. Gray.‡

A few words more only remain to be said about the lowest form of the Mammal-type in South America, the Marsupials, which the New World possesses in common with Australia. But whereas in Australia Marsupialism is the prevalent form of Mammalian life, and exhibits itself in several very distinct families, only one group of Marsupials exists in the New World to which it is likewise peculiar. This is the family of Opossums (Didelphyidæ), containing three principal genera (*Didelphys*, *Chironectes*, and *Hyracodon*). The first of these contains a series of species of arboreal habits, varying in size from the bulk of a common cat, such as the Virginian Opossum (*D. virginiana*), to that of a common house-mouse, such as *D. tristriata*. They are diffused all over Southern and Central America, from the

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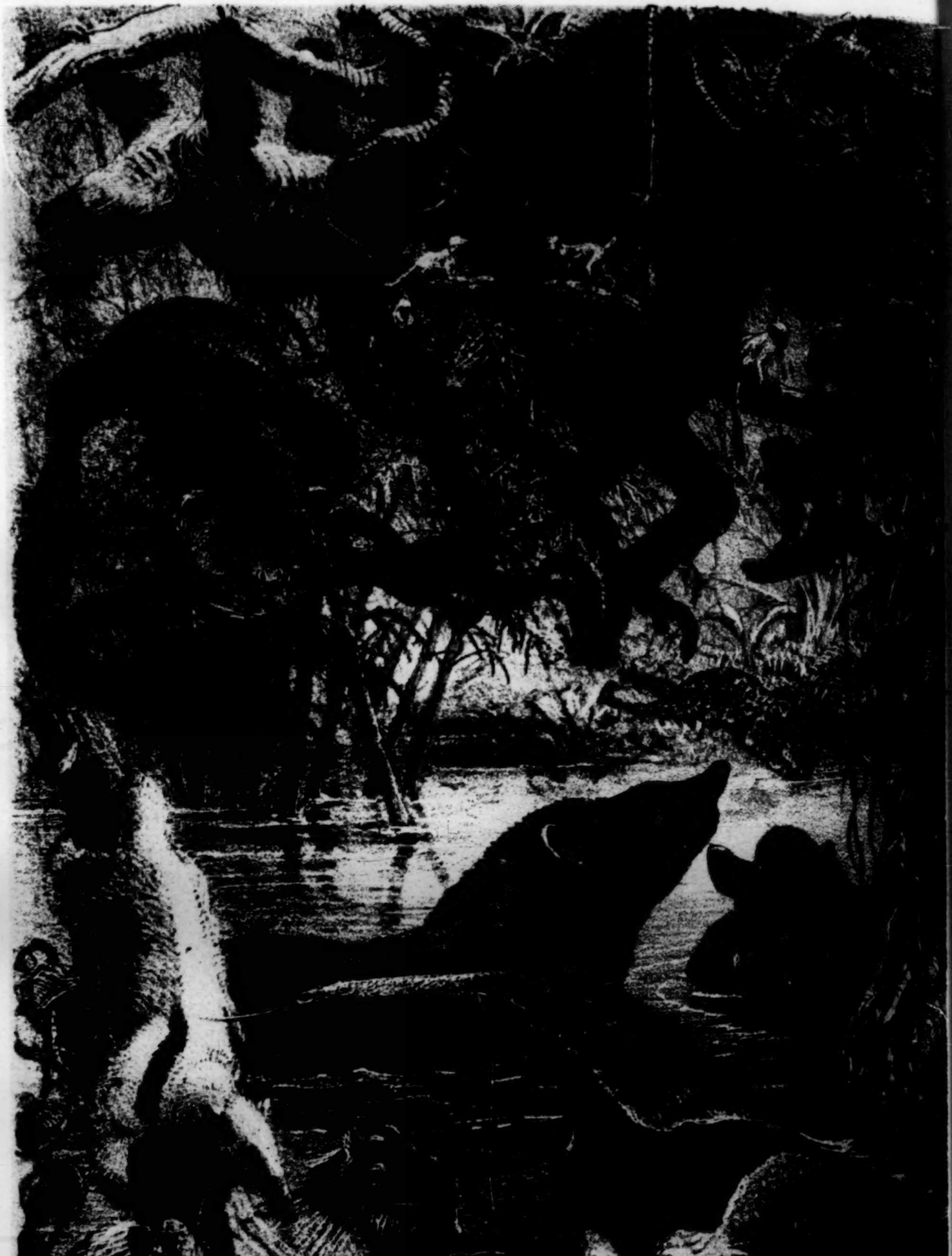
* *Ch. hoffmanni*, Peters.

† Cf. de Saussure, 'Rev. Zool.,' 1860.

‡ *C. dorsalis*, Gray, 'Proc. Zool. Soc.,' 1865, p. 385, pl. xviii.



J. Wolf, del et lith.

M & N Hanhart imp

TYPICAL MAMMALS OF SOUTH AMERICA.

Rio de la Plata to the United States, but seem to be most numerous in Brazil, whence some twenty species have been obtained. *Chironectes*, the second genus of American Marsupials, contains only one known species, the *Chironectes variegatus*, or Water-Opossum of Brazil and Guiana, distinguished by its aquatic habits, as well as by modifications of structure which adapt it to that mode of life. *Hyracodon*, the third and last, likewise contains only a single type remarkable for its Insectivorine dentition, which has been recently made known to science by Mr. Tomes.*

Having now done my best to give a general outline of the principal forms of Mammals found within the Neotropical area, it only remains to recapitulate the principal characteristics which distinguish this region from the other great regions of the world's surface. These, I think, may be stated as follows:—

1. The possession of two families of Quadrumana (Cebidæ and Hapalidæ), constituting a special section of this Order (Platyrhina) peculiar to this region.
2. The absence of the true frugivorous Bats (Pteropodidæ) and the presence of a peculiar family of Chiroptera (Phyllostomatidæ), some forms of which are frugivorous, and others feed solely on the blood of living animals.
3. The absence of Insectivora, except the singular genus *Solenodon* of the Antilles.
4. The absence of Viverridæ, and the presence of several peculiar genera of Carnivores (*Icticyon*, *Galictis*, *Nasua*, and *Cercoleptes*).
5. The absence of true *Mus*, which is replaced by *Hesperomys* and allied forms, and the presence of numerous forms of Hystricidæ, constituting nearly the whole of this extensive and varied family.
6. The absence of Proboscideans and Perissodactyles, except Tapirus.
7. The great poverty of Ruminants, the family Bovidæ being entirely unrepresented, and only *Cervus* and *Auchenia* occurring out of the whole Sub-order.
8. The presence of three families, containing by far the majority of genera and species, of Edentates.
9. The possession of a peculiar family of Marsupials, which has intruded itself into the Nearctic Region, but is unknown elsewhere.

DESCRIPTION OF THE ILLUSTRATION.

Mr. Wolf's plate represents a (rather crowded) scene in a Brazilian forest. Hanging from the branches in the left-hand corner is a two-toed Sloth (*Cholœpus didactylus*). Below it is a Kinkajou (*Cercoleptes caudivolvulus*). In the upper right-hand corner are various American Monkeys (*Cebus*, *Callithrix*, *Pithecia*), with a large Spider Monkey (*Ateles*) hanging by its tail in front. On the ground is a pair of Armadillos (*Tolypeutes tricinctus*), to the right a great Anteater (*Myrmecophaga jubata*), and, with its prehensile tail coiled round a tree, to the left a Tamandua Anteater (*Tamandua tridactyla*). A pair of Tapirs (*Tapirus americanus*) are enjoying a bath in company with a Capybara (*Hydrochœrus capybara*), while a Jaguar (*Felis onca*) is drinking in the background.

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* 'Proc. Zool. Soc.,' 1863, p. 50.

STRATA IDENTIFIED BY ORGANIC REMAINS.

By H. M. Jenkins, F.G.S , Assistant-Secretary of the Geological Society.

'Strata Identified by Organized Fossils' was the title of a well-known work by William Smith,* in which he illustrated his discovery that the numerous formations constituting the crust of the earth could be distinguished and identified by means of their imbedded fossils. The term "organized fossils" was used by this celebrated author because all kinds of imbedded minerals and stones, whether of organic origin or not, had previously been called "fossils;" but, as the latter epithet became restricted in its meaning, so as to be synonymous with the former, the term "organized fossils" became obsolete, and "fossils" were spoken of simply as such, or as "organic remains;" thus we arrive at the origin of the title of this article,—"Strata Identified by Organic Remains." In these pages I shall endeavour to examine the present state of geological opinion respecting this great generalization of the "Father of English Geology," as William Smith has been appropriately styled, for his discoveries, especially the one which now most concerns us, have undoubtedly been the foundation of all modern Geology.

This discovery gave a new direction to geological inquiry. Before its promulgation geologists had been contented to describe strata as so many rocks and minerals, having certain peculiarities of dip, strike, colour, hardness, and so on; and the imbedded fossils were merely considered to be extremely curious and more or less adventitious; in fact, they were at one time called "extraneous fossils," a term which has since obtained a widely different and very much restricted meaning. Afterwards, however, they necessarily became invested with a higher interest, for they were shown to be not only curious, but also extremely useful and important. Zoology and Botany received a great impetus, both on account of the light they threw on the nature of fossils, and because of the number of new and curious organisms discovered in the fossil state, which helped to explain aberrant recent forms. It was now, also, no longer necessary to trace a continuation between the rocks of two or more localities to be assured of their identity; if they contained the same fossils, they were as absolutely "identified" as if their physical continuation were exposed along their whole line of strike. Henceforth the labour of tracing the distribution of strata was very much reduced, as also were the chances of error; consequently the characters of fossils received a vast amount of attention, and their study rapidly became a science of itself, and this new science —Palæontology— has completely changed the aspect of its parent, and in many instances has altered its language.

Palæontologists were soon enabled to show that the older the stratum whence organic remains were derived, the less resemblance did the fossils bear to recent organisms, and the more dissimilar to the recent did the fossil faunæ become. This induction was quickly followed by an attempt at classifying the rocks into great systems and subordinate formations and beds; but into the details of these efforts I need not enter. Naturally the next step was to compare the formations of different countries, to ascertain the coincidences, and to find out the gaps. And thus we come to the line of research that first suggested a modification of the accepted doctrine,—"Strata Identified by Organic Remains."

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* Published in 1817.

Englishmen have generally been foremost in every field, from breaking stones as geologists to scaling the Matterhorn; and, as Sir Roderick Murchison has just remarked, in his Presidential Address to the Geological Section of the British Association, the great divisions of Silurian, Devonian, and Carboniferous, first established in England, have been adopted on the Continent. The attempt to correlate the formations of different countries was pursued with great zeal and good results, and at first without endangering the universal application of William Smith's great law; but as Palæontology advanced, her votaries became more critical, and infinitely better naturalists, and they found that, as the distance between similar formations increased, the proportion of identical species became smaller. The explanation generally given and readily received was, that this difference in organic contents was due to difference of latitude and to local modifying causes, and thus "Strata Identified by Organic Remains" continued to be accepted both as a motto and a law, a foundation of faith on which the whole structure of modern Geology was built, and the truth of which was unassailable.

Such being the state of Geological opinion, what was the astonishment of the Fellows of the Geological Society when, at one of their meetings in March, 1846, Professor Edward Forbes declared "that identity of fossils in strata geographically far apart must lead to the inference that the beds were of *different*, not, as hitherto maintained, of the same age."* But although Geologists were astonished, and perhaps, as Edward Forbes expressed it, "terrified," their astonishment or terror took no practical shape. The promulgator of this new doctrine, like most men of genius, was in the habit of giving vent to apparently strange ideas, some of which were the result of careful observation, combined with great extraneous knowledge and a powerful imagination, while others were due to the imagination alone, and required time for their merit to be acknowledged. Accordingly his heresy did not produce any permanent effect at the time, notwithstanding the "terror" it excited, and it was not until sixteen years afterwards that the subject was revived in a manner sufficiently authoritative to challenge public attention. Then, in 1862, Professor Huxley took the opportunity afforded by an Anniversary Address to the Geological Society to bring this heterodox doctrine again before the notice of that learned body, and since then several of the younger palæontologists have given the idea its due weight in endeavouring to correlate distant deposits.

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* *Vide* Wilson and Geikie's 'Memoir of Edward Forbes,' p. 395

Having given a brief outline of the history of our subject, I must endeavour to explain the reasons that induced Professor Edward Forbes to give utterance to the sentence I have just quoted, and that instigated his successors to revive his opinion. Let us suppose that during the deposition of the most ancient fossiliferous rocks, the world was peopled by a single assemblage of animals and plants; in other words, that the same aquatic species existed in every part of the ocean under the same conditions, and the same land-species on the whole surface of the dry land, also under the same conditions. In this case it is obvious that the strata of that period could now, all over the world, be absolutely identified by their organic remains. But if we take a survey of the fauna and flora of the globe as they now are, we shall find that the very reverse of our supposition is what occurs at the present time; for the surface of the earth consists of a number of zoological and botanical provinces, each one of which has an assemblage of animals or plants more or less peculiar to it. It is therefore very unlikely that a geologist of some Post-Quaternary period will be able, with our means and appliances, to identify and correlate by their organic remains distant deposits of our period; such, for instance, as are being formed in the Baltic and on the shores of the Indian Ocean.

But this is by no means the whole of the case for the opponents of the old view. The views of all geologists on this question must depend more or less on their belief in the origin of species by descent with modification, and from single "specific centres." Taking first the affirmative view of these theories, it must be allowed that it takes a considerable time for a species to extend itself over a large area from the spot where the modified descendant could first be called a new species; but it takes a still longer time, after the full geographical extension of the species has been reached, for that species to emigrate to a distance in consequence of a change in the conditions of existence, such as alteration of climate, in the depth of the sea, in the abundance and quality of food, &c. In illustration of this point I may cite several facts, especially the occurrence of the Reindeer in the South of France during a late, but still pre-historic period, and its existence at the present day in Arctic regions. Again, *Cyrena fluminalis* (Plate, fig. 1) occurs abundantly in the brick-earths and gravels of the Thames Valley, and exists now in the rivers of more southern latitudes, ranging from Egypt to China; and a parallel instance is afforded by *Argonauta hians* (Plate, fig. 2), which occurs fossil in Pliocene European deposits, and ranges now as far as the coasts of China. A stronger case is, perhaps, afforded by the fact that a large number of species which occur fossil in the Miocene deposits of Europe (for instance, Plate, fig. 3) live now in tropical latitudes, chiefly on the shores of the Indian Ocean, so that the fossils of the strata now being deposited in that region cannot be very different in facies from those of the Miocene formation of Europe.

One apparent objection to this doctrine becomes a corroboration, when subjected to a searching examination, as is not unfrequently the case with unsound objections to true theories. Opponents to the theory of descent with modification, who are also advocates of the orthodox maxim of "Strata identified by organic remains," will say—"But if these species came into being first, for instance, in the Miocene seas of Europe, and emigrated thence south-eastwards as the climate of Europe changed, they should, according to your views, have undergone some alteration by the way;—in other words, they should by this time have been 'modified' into new species." The corollary that would be drawn from this is that the 'descent with modification' doctrine is incompatible with the other.

In reality, however, it is only the strongest and most stable of the Miocene species that did withstand the wear and tear of their long voyage; the great majority of them were "modified" into the "representative species," as Professor Forbes called them, which now exist in sub-tropical regions, their Miocene ancestors being extinct. The more hardy species which did contrive to exist unchanged (such as the one represented in Plate, fig. 3) remain as witnesses to prove the emigration, while the more changeable forms, by having become altered so much as to be considered new and representative species, bear testimony to the effect that is so often wrought upon species by a change in the "conditions of existence," and also to the probable truth of the theory of descent with modification.

A very interesting example of a variation which *may* be due to a process of modification has occurred to me during the examination of Miocene Mollusca from different parts of the world. In 1863, I described and figured a Tertiary shell from Java (Plate, fig. 8), which appeared to be the young of the recent *Oliva utriculus;* but although I had a large number of specimens, not one of them seemed to have reached the adult state. In other respects there was scarcely the most fractional difference to be detected between the fossil and the young of the recent species, but the former differed very markedly, of course, from full-grown specimens of the latter (Plate, fig. 9). Since then I have met with another series of specimens of the same species from the Miocene strata of Crete, exactly corresponding with those from Java, and all presenting the characters of the young of *Oliva utriculus*, but unassociated with any specimens comparable to the adult state of that species. Now it appears probable, that during the Miocene and later Tertiary periods this shell never got beyond the young state of the existing species; and that its present excessive growth and development, owing probably to very favourable conditions, may be but a portion of a course of modification that will ultimately produce a sufficient divergence in the two forms to entitle them to rank as distinct species. In fact, if we were not so well acquainted with all the stages of growth of the recent form, they would be considered so now.

Having used the term "representative species," it is necessary to define it. Those species, then, are "representative" which appear to hold a place in one zoological province, or geological formation, corresponding to that held by the species they represent in an equivalent province or formation. Sometimes the representative species are clearly very closely allied to those they represent; but it frequently happens that they are only analogous species. In illustration of this latter point I may mention that in the Tertiary strata of Victoria and South Australia are found a number of species of *Voluta* with blunt spires,* but otherwise scarcely distinguishable from the Eocene sharp-spired species of *Voluta* occurring in Britain (compare Figs. 4 and 5 of the annexed Plate). But does it therefore follow that these two sets of strata, so widely distant from one another, are of the same age? By no means, as it seems to me. For, leaving the distance out of the question, for fear of being charged with the fallacy of "begging the question," all the *actual* evidence (as distinguished from the *ideal*) goes to prove that the Australian beds are much the more recent. In these beds the curious species of *Trigonia*, which formed the subject of a note by me in the April number of this Journal, has been found. It is represented in Fig. 6 of the Plate, and the type of the group to which it belongs (*T. costata*, an Oolitic species) in Fig. 7.

Zoologically, therefore, if two series of strata can be correlated only by means of representative species, their actual ages ought to differ more widely than those which have some species in common. And observed facts really give strength to this inference, for it rarely happens but that the less distant strata, presumably contemporaneous, have more species in common than those which are more widely separated. This argument may, of course, be pushed still farther, as when the species cease to be evidently representatives, or when they belong to different genera; but it must always be borne in mind, that it has no force whatever unless strong collateral evidence exists, such as would ordinarily induce a geologist or a palæontologist to correlate the one formation with the other. There are no strong lines in nature, and when the affinity of the fossils of two formations becomes very weak, it ordinarily happens that we must look above or below the one selected as a standard for comparison, in order to find the deposit which seems, *primâ facie*, to be the nearest in age to the one we wish to correlate.

The fearful palæontologist may ask what limits are to be placed upon the apparent difference in age of two formations apparently contemporaneous. In mathematical language, what is the *function* with which we are to differentiate the ages of apparently contemporaneous strata? It appears to me that we have that function in the term Geographical Space; for I believe that as the distance between the formations becomes greater, so does, *cæteris paribus*, the difference in age increase. In other words, Geographical Space and Geological Time have the same sort of correlation as Electricity and Magnetism; with apparently contemporaneous strata a certain distance means a certain lapse of time, and as one varies so does the other. Still, this is an individual opinion, and it does not quite coincide with that expressed by other writers. Professor Huxley, for example, states that, "For anything that geology and palæontology are able to show to the contrary, a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a Carboniferous fauna and flora in Africa. Geographical provinces and zones may have been as distinctly marked in the Palæozoic epoch as at present, and those seemingly sudden appearances of new genera and species, which we ascribe to new creation, may be simple results of migration."* This seems to be pushing the conclusion rather beyond the limits of logical inference, unless geological time is something very different from what the students of Hutton and Lyell have been taught to believe.

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* See Prof. M'Coy's Contribution to the 'Victorian Essays,' p. 168.

Mr. Seeley, however, with greater enthusiasm and less caution than Professor Huxley, makes the apparently extraordinary statement that "Palæozoic, Mesozoic, and Tertiary, are convenient fictions."† But it is not unlikely that, though he appears to say more, this palæontologist actually means the same as myself, namely, that there is no *absolute* division all over the globe between rocks of Palæozoic, Mesozoic, and Tertiary ages; for it is conceivable to me that the Maestricht Chalk may have been deposited contemporaneously with apparently Eocene beds in another region, and with apparently Lower Chalk strata in a third.

The same author begins another memoir ‡ by the, to some, equally startling heresy that "The evidence of a rock's age derived from fossils can never be quite conclusive, and never rank as equal in value with sectional evidence;" but I imagine that in this instance he must refer to cases where a lithological continuity can be traced, and not to widely separated and totally unconnected sections. It is conceivable that sectional evidence may sometimes be superior to palæontological; but I should very much doubt whether it is possible that this should always be the case. I can understand why the presence of certain minerals, which have always before been found to characterize particular deposits, or the existence of certain structural peculiarities, such as have hitherto occurred only in rocks of one period, should determine the age of a stratum at a great distance from its supposed analogues much better than weak or scanty fossil evidence; but it happens more frequently than otherwise that the palæontological evidence is very much stronger than either the stratigraphical or petrographical, in regard to the question of correlation with unconnected or distant deposits.

A fertile source of error in the determination of the synchronism of geological formations lies in the very different depths of the sea-bottoms on which strata of the same period may have been deposited. This refers equally to mineral composition and fossil contents, for while the sediment deposited varies, generally speaking, from the pebbles of the sea-shore, through sand to clay, and thence to the coral-reefs and calcareous deposits of the ocean, so the inhabitants of these different zones exhibit a gradual change, not only in species but also to a large extent in genera; consequently it would be extremely difficult to correlate the littoral accumulations of one region with the deep-sea deposits of another. This is only one of the many sources of complication that render the problem of the relative age of distant deposits so very difficult of solution, and that conspire to place CAUTION at the head of the cardinal virtues in the code of morality recognized by palæontologists.

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* "Address Geol. Soc.," 1862, p. 22. 'Quart. Journ. Geol. Soc.,' vol. xxviii. p. xlvi.

† "On the Significance of the Sequence of Rocks and Fossils." 'Geol. Mag.,' vol. ii. p. 264.

‡ "On the Fossils of the Hunstanton Red Rock." 'Annals and Mag. Nat. Hist.,' 3rd ser., vol. xiv., 1864, p. 276.

Philosophical geologists, who cannot but admit the weight of the arguments that have been put forth in favour of the doubtfulness of the relative age of strata apparently contemporaneous, but who are still unwilling to admit such an element of uncertainty into their reasonings, for fear that it would prove a kind of inductive guillotine always ready to fall and cut off their otherwise legitimate inferences, take refuge in an assertion that may be stated in the words of Professor Ramsay, one of the most eminent and philosophical of the geologists who cling to the old notion; he says, "It appears to me, however, that such reasoning is in error, simply because the reasoner is apt, unintentionally, to consider a whole formation, perhaps from 1,000 to 7,000 feet thick (as in the case of the Bala beds and Hudson River group), as if it were *a bed or a thin set of beds representing a particular sea-bottom at a particular time*, whereas the Bala beds represent a great many thousands of sea-bottoms more or less regularly piled on each other very slowly. The question must therefore arise, in connection with duration of species, whether under any circumstances the possible time, for instance, that it might have taken to transmit species from the English to the American area is likely to be comparable to the amount of time represented by the interval between the lowest and the highest Bala strata, *or even of a longer period.*"* The gist of which statement is, that the lapse of geological time, which takes place during the deposition of a formation like the Bala beds, is something so overwhelmingly great in comparison with that required for the emigration of a fauna to a great distance, that the occurrence of the emigration during the deposition of such a formation would have no appreciable effect on the true, in relation to the apparent, relative ages of even a minor subdivision of them. But I have already hinted in this article (p. 624) that the recent East Indian Mollusca are so clearly related to European Miocene species that deposits now being accumulated near the shores of the Indian Ocean might easily in future be mistaken for Miocene, and Dr. Duncan has conclusively shown that European Miocene Corals are distinctly East Indian in their affinities. Now the Miocene formation may be roughly considered to be nearly of an equivalent thickness to that of the Bala beds, and many of these East Indian shells occur in its lowest subdivisions. But of more recent date we have the whole of the Pliocene and younger deposits, which attain, probably, in places, an aggregate thickness of 4,000 or 5,000 feet more. And yet, notwithstanding this great mass of material that has been deposited since the Miocene fauna first appeared in Europe, it appears to me that there is not sufficient difference between it and the existing East Indian fauna to warrant any future "Post-quaternary" geologist with our present principles, taking into account the difference of latitude, and not giving any weight to the doctrine I am advocating, in assigning it to any other than a Miocene period. Therefore I believe that the time required for the deposition of a formation several thousand feet in thickness, is not necessarily greater than that required for the emigration of a fauna to a great distance, when caused by a change of climate or a considerable alteration in the physical features of the earth's surface.

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* Address Geol. Soc., 1863, p. 25.

Professor Ramsay makes another objection that requires a few words of explanation, as he considers it of importance. He remarks that, "if the idea put by Professor Huxley be just, it appears to me that in the piles of formations built up in Britain, on the Continent, and in America, the chances are overwhelmingly strong, that in each or in some one area there might be a *recurrent fauna*, which is not the case. To this I attach great weight." * There are two answers to be given to this objection: first, when the physical changes have not been sufficiently great to expel the fauna completely, then we do get an actual recurrence, of part of a fauna, at least; secondly, that when the physical changes have been very great, they must have occupied so long a time and caused such an alteration in the conditions of existence, that the species had to "flee for their lives." In the "struggle for existence" that followed, under new and more or less unfavourable circumstances, many were exterminated, and the majority of the survivors so changed that they are now considered different species from their ancestors. As I differ from Professor Ramsay in the first part of my answer, I ought to prove my assertion. This cannot be done better than by a quotation from his own Anniversary Address to the Geological Society, for the following year; it runs thus, "The majority of the forms that passed upwards from the Inferior Oolite limestone, seem to have fled the muddy bottom of the Fuller's Earth sea, and to have *returned to the same area*,† when the later period of the Great Oolite began." ‡ Here, therefore, Professor Ramsay acknowledges the occurrence of a recurrent fauna.

There is but one other phase of this question that I shall now endeavour to discuss, namely, that if widely separated strata apparently contemporaneous are not really so, it may be urged that it becomes almost a farce to attempt to correlate distant deposits, unless we have some golden rule with which to find out their difference in age. Mr. Salter has neatly enunciated this kind of scruple, by saying that "it is hard to have to question every conclusion as it arises," § and doubtless it is a very hard thing at first; but as all men of science love, or ought to love, truth more than apparent symmetry, they will soon get over this feeling, and in the meantime we must seek for a remedy to assist them in doing so. Such a remedy has been proposed by Professor Huxley, in his Anniversary Address already quoted. He has suggested that instead of the term 'contemporaneity,' we should substitute a word that would express similarity of serial relation, but would exclude the notion of time altogether, and has proposed the term 'homotaxis' (similarity of order) as embodying that idea, and as a parallel to 'homology,' which is used in anatomy to express correspondence of position. This term 'homotaxis' was suggested in 1862, and as yet only one palæontologist of note, namely, Dr. Duncan, has used it in his writings instead of the terms 'contemporaneous' and 'synchronous,' neither of which conveys the exact meaning of those who, like myself, believe that the absolute contemporaneity of distant deposits cannot be strictly determined. But it is something for one high authority to have "broken the ice" within three years.

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* Op. cit., p. 26.

† The italics are mine.

‡ Address Geol. Soc., 1864, p. 26.

§ 'Geol. Mag.,' vol. i. p. 5.

If 'homotaxis' is to be used instead of 'contemporaneity,' we must have its adjective, 'homotaxeous' as synonymous with 'contemporaneous;' and I cannot see any reason why these terms should be objected to on account of their novelty. Every new idea, like every new machine, must have a new name; and if the name has not been given until the idea has become tolerably familiar to us, there is greater reason why it should not now be objected to. There is also this additional consideration, that if our inferences are based on the 'homotaxis' of formations instead of their contemporaneity, there will be no necessity to "question every conclusion as it arises."

EXPLANATION OF THE PLATE.

Fig. 1. *Cyrena fluminalis*, fossil in the Post-pliocene deposits of England, Belgium, &c., recent in the Nile and some Asiatic rivers. Twice the natural size.

Fig. 2. *Argonauta hians*, fossil in the Sub-Apennine deposits of Italy, and ranging in the recent state as far as China. Natural size.

Fig. 3. *Eburna spirata*, fossil in the Miocene strata of Bordeaux, recent in the East Indian Ocean. Natural size.

Fig. 4. *Voluta strophodon*, M'Coy, MS., from the Miocene deposits of Australia. Natural size.

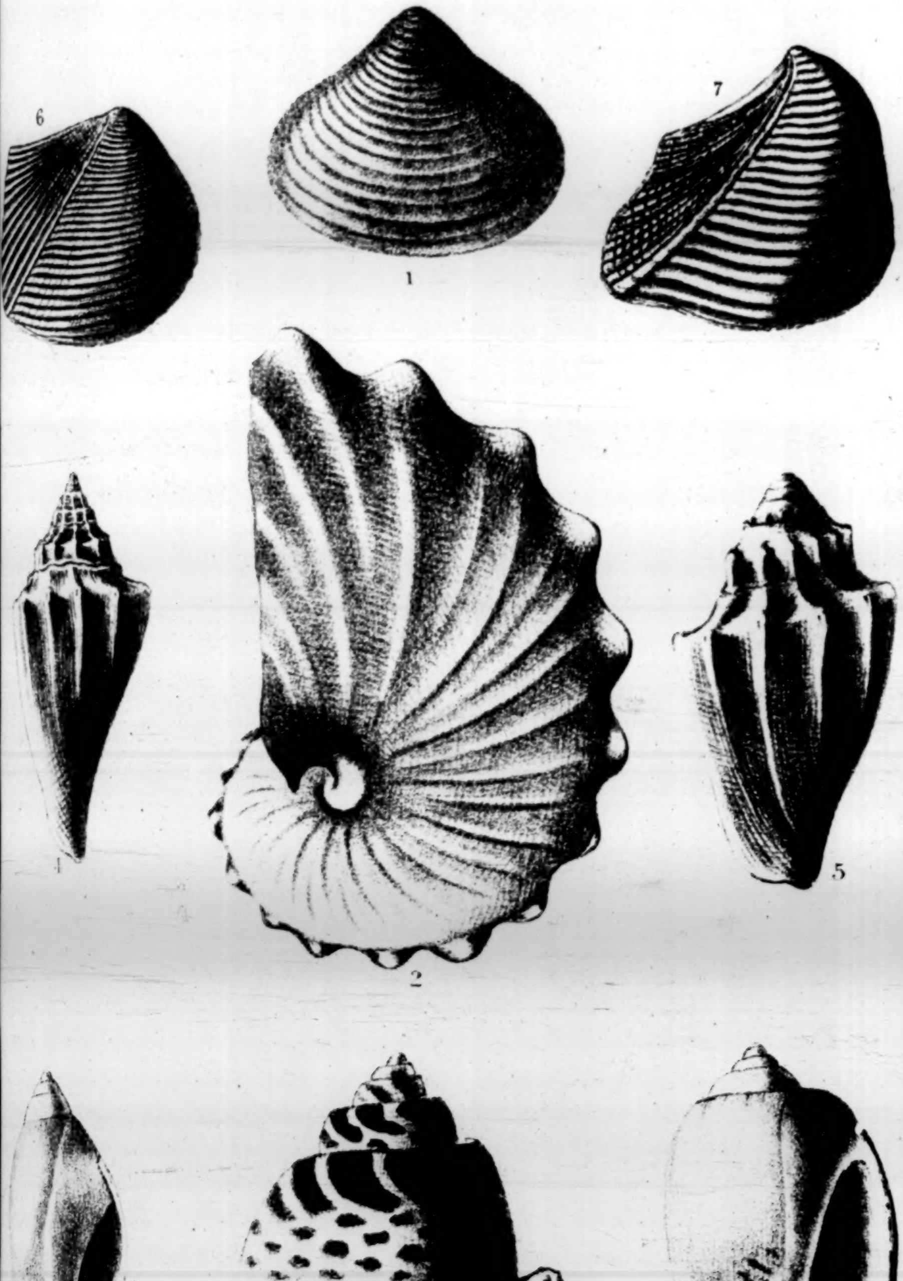
Fig. 5. *Voluta spinosa*, from the Eocene beds of England and France. Natural size.

Fig. 6. *Trigonia semi undulata*, M'Coy, MS., from the Miocene deposits of Australia. Natural size.

Fig. 7. *Trigonia costata*, from the Oolitic formations of England and the Continent. One-third the adult size.

Fig. 8. Adult Tertiary *Oliva*, from Java and Crete, apparently identical with the young of the existing *Oliva utriculus*. Twice the natural size.

Fig. 9. Full-grown specimen of *Oliva utriculus*, from Africa, showing the adult characters. Natural size.



Wilde lith. ad nat.
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THE NORTH POLE.

By the Rev. C. W. KETT, M.A.

IT is not the province of Science to prophesy. It is perfectly possible from certain data to arrive at conclusions from which there is no escape in regard to many matters of exact science. Thus Adams and Le Verrier could both calculate from certain noticed observations of Uranus, that some attractive power in a particular position was influencing the orbit of that planet, and well-directed investigations towards this point afterwards discovered the planet Neptune in the position assigned. So far Science, where the influences were few, could demonstrate what afterwards proved to be a fact. But on this globe, though the laws of nature as we grow better acquainted with them seem fewer and simpler, their modifications nevertheless are so numerous, and the manifestations of them are so various, that the mind of man cannot as yet predicate with any certainty, that of which it is unable to make trial by experiment, or of which experience gives it no knowledge. It is not therefore with any pretence of foretelling what will hereafter be determined to be true or untrue, that the following lines are written, but with a view to place before your readers the various arguments that may be adduced in favour of there being either open sea, continuous ice, or snow-covered land towards the North Pole.

The prospect of an expedition in that direction naturally leads men's minds to speculate on what the explorers will meet with, and the necessity of preparation for any contingency compels those interested in these matters to compare the evidence that may be brought to bear on a point of such importance. But supposing the evidence either way were many times more conclusive than it is, we should not be justified in being unprepared for the other contingency, or in so far prejudicing our minds in favour of either hypothesis that we should find a difficulty in receiving any direct evidence of known credibility in the opposite direction.

Undoubtedly the common opinion with regard to the North Pole, is, that as in going northward from the equator to the arctic circle we find the cold gradually increasing, or, to speak more precisely, the heat decreasing, so if we go farther, a motion in the same direction still continues, and that thus by a simple progression sum we might calculate with somewhat of precision, the degree of cold that would be reached in a particular latitude. And again, to argue from the analogy of our nearest neighbour in the solar system, we have been enabled of late years to see that the planet Mars possesses climatic variations similar to those of the earth, and especially it has poles like our own, covered with ice and snow, descending in the winter nearer to the equator; and again in the summer assuming smaller proportions. Towards the extremity of the poles of Mars nothing has as yet been perceived which would indicate any modification of this constantly increasing cold; no spot has been noticed that would lead one to suppose that the snow was not continuous and unbroken. Why therefore should we doubt that the same process takes place in our own planet? Simply, we may answer first, because nothing is more deceptive than to argue in physical science from what seems to be a well-chosen analogy.

Direct evidence seldom has the same weight as circumstantial, we shall therefore bring forward this our least trustworthy argument first: In the year 1818, Messrs. Barrington and Beaufoy, Fellows of the Royal Society, produced the evidence of several Dutch skippers, to the effect that they had succeeded in reaching within two or three degrees of the pole, that they had found there a sea of comparatively warm temperature, and that there was a swell which indicated no very close proximity of land. One man went so far as to declare that he had passed some two degrees beyond the pole. At this distance of time it is almost impossible to arrive at a very clear idea of the value of the evidence here given. Numerous skippers of whalers told tales of having approached and even passed the pole, after having penetrated the pack ice to the north of Spitzbergen, but whether these were the deliberate accounts of men who really believed that they had done as they had stated, or were mere travellers' tales, it is impossible now to say. And again, if these accounts were given in good faith it may well be doubted whether these men were not deceived through ignorance of some of the now well-known laws which govern the needle and other physical phenomena.

Soon after the last of these statements was made public, Baron Wrangel, accompanied by Lieutenant Matthiewskin, made several attempts to penetrate northwards from the coast of Siberia, but after having crossed some considerable space of ice, they were on each occasion met by open water, which checked further advance. This circumstance naturally drew men's attention to any fact which might lead to similar conclusions, and may well now draw our attention to the indirect but more trustworthy evidence.

A study of the condition of the sea about Spitzbergen has brought to light some curious results. It has been noticed that all the icebergs to be found in this locality consist only of frozen sea-water, not of masses detached from land-glaciers, as the icebergs of either coast of Greenland invariably are. Moreover, no terrestrial remains, according to the observations of Scoresby, occur on any portions of the ice to the north of Spitzbergen. To the east of that island less pack ice occurs than farther west. Sir Edward Parry (and this is direct evidence of a very different character from that mentioned before) advanced as far north as 82° 40′ North latitude, or within $7\frac{1}{2}$ degrees of the pole, the highest latitude as yet reached in open sea to the north of Spitzbergen of which we have any authentic information, and when he was compelled to return he still saw open sea before him.

The narrow channels to the north of the Western Continent, into which innumerable ice-rivers pour their huge masses of frozen material continually, are soon blocked up by the icebergs thus formed, so that currents are stopped, the wind can affect them but slightly and that only at intervals, whilst in the meantime the cold attacks the intermediate spaces of undisturbed sea, and iceberg is linked to iceberg, and channels are bridged across by plains of level ice which, even when crushed, piles up to form other icebergs, or, when rent asunder, leaves comparatively narrow fissures; these in their turn are spanned by a fresh coating of newly-formed ice. Throughout all the exploring ground that we know best, that namely to the north of the American continent and of Greenland, this is the constantly recurring cycle of events every winter. But farther east, to the north of Spitzbergen, the sea is more open, there is no trace of glacier action, no masses of ice are poured into the already freezing sea to form the nucleus of fresh congelation; the ocean currents are mighty, and wind wantons with waves, defying the ice particles, if formed, to adhere to one another.

The farther we proceed from the Western continent the more these conditions are increased: the Gulf Stream, in its mighty sweep across the Atlantic, ends not its course when it arrives opposite to the shores of our own island, nor even when it breaks against the rugged coast of Iceland. It separates certainly; the more westerly branch, verging towards the coast of Greenland, is soon merged in the south-flowing arctic currents—it turns on itself and is lost; but the more easterly continues its course and steers between the coasts of Iceland and of Norway on to Spitzbergen and beyond, until the impetus of this body of water is exhausted, but whether against the ice-wall in midst of the northern sea, or against the shores of the land on the other side of the pole, remains to be proved.

According to some of the greatest geologists of our time, there has been no geological period during which we can trace the effect of terrestrial icebergs descending from the arctic seas to the West of Spitzbergen. All along the coast of Europe, in England, Scandinavia, Germany, and Russia, erratic blocks of boulder-stones mark the progress of these early carriers; but to the east of the Ural, the results of their progress disappear, so that though we can scarcely believe that icebergs have not travelled southwards to the coast of Siberia, still they have brought nothing with them to mark whence they originated or where they settled; and if they brought no traces of the land about the glaciers from which they sprung, we may suppose that they were rather sea-born than of earthly parentage.

The effect of wind upon open water is very considerable, the force of rapidly moving air dashing against the uneven surface of the ice, even if not accompanied by a rise in the temperature, is very great, extending, as has been testified by numerous arctic explorers, even to the breaking up of extensive floes of ice from twenty to thirty feet thick. But besides the mere force of the wind in shattering these fields of ice, these storm-blasts are frequently accompanied by a rise of the thermometer, the wind coming from a warmer region. In the coldest parts of the earth the winds must almost invariably come from warmer climates; thus a predisposition to disintegration is produced, which, in combination with the violence of the wind, again works, and when once the ice is broken up, the sea itself is disturbed, waves of considerable height are raised, the water of various depths is intermingled, each depth having its own increasing temperature, until that depth is reached in which is found the invariable marking of 39° Fahrenheit; and this water being brought to the surface, the air around is warmed and saturated with moisture, and finally we have the phenomenon of rain in the midst of an arctic winter. We have several records of such changes of temperature as are here referred to from the coast both of America and Asia, on opposite sides of the pole. Baron Wrangel speaks of a wind on the Siberian coast, from the S.E. by E. which causes a rise in the temperature from — 24° to + 25° or even + 32°. The Danish colonists of Upernavik, in North Greenland, say that frequently in the depth of winter they experience a warm south-easterly wind, which brings with it abundance of rain, a most unwelcome change of weather when they are only prepared to fence out cold. In the Private Journal of an officer of the 'Fox,' given in the first number of the 'Cornhill Magazine,' it is mentioned that late in December, when beset in the ice of Baffin's Bay, the daring voyagers experienced a warm wind from the N.N.W., and again Dr. Kane was met in January by what was at first a snow-storm, accompanied by much south-east wind, but which finally resulted in a thaw, indicating a rise in the thermometer of more than 70° in two days.

We may then sum up the evidence in favour of open sea northwards, for some considerable distance from Spitzbergen, into (1) the direct evidence of early navigators, principally Dutch, confirmed by the far more authentic evidence of Sir Edward Parry, as far as he went (82° 40′ N. lat.); (2), the absence of all evidence of land to the north of Spitzbergen, when such evidence might have been expected from icebergs or from the ordinary indications of land at some distance from the shore; (3), the confirmatory testimony of the power of ocean current, of open sea swell, and of storms of wind sometimes bearing heated atmosphere with them, stirring up the lower water of the ocean, which is known to be at all times at a fixed degree above freezing point. This evidence tends to prove that to the north of Spitzbergen no land interrupts the flow of the ocean, and that when the ocean is not divided into small channels, it is seldom entirely frozen over all the year round.

It is to be hoped, however, that an expedition northwards will ere long be fitted out, and that these speculations will then be set at rest, and that you will be able to place before your readers some more definite evidence as to the nature of both terrestrial and climatic condition of the country about the North Pole. In the meanwhile, should such an expedition as I have alluded to receive the sanction of Government, it must be remembered that whilst the route by way of Spitzbergen* holds out the inducement of a *probability* of open water for a great distance towards the hoped-for goal, we can arrive at no certainty until the expedition has taken place, and the explorers, whichever route may be chosen, must be *in utrumque parati.*

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[*] Dr. Petermann, of Berlin, is so fully persuaded of greater feasibility of the route by way of Spitzbergen, that he has offered a premium of from 150*l.* to 300*l.* to any German mariner who will explore the ocean currents between that island and Nova Zembla, preparatory to an expedition to the pole from that quarter.

BRITISH GOLD,

With Especial Reference to the Gold Mines of Merionethshire.

By Robert Hunt, F.R.S.

The discovery of Gold in Britain has, from the earliest recorded times, been a question of much interest. There is every reason for believing that before the Roman invasion this precious metal was known to the inhabitants, and prized by them. Julius Cæsar was induced to the invasion of these islands, from the report of the immense mineral treasure possessed by the people; and Tacitus, in his 'Life of Agricola,' distinctly tells us "in Britain are gold and silver and other metals." The early discovery of gold, even by ignorant men, is easily explained. It would be found in the beds of streams, left dry in summer, and the density and colour of the stone would very naturally attract attention. The metallic nature of the discovery would be readily detected by men who had already made themselves familiar with tin; and it is well to remember that all evidence is in favour of the belief, that tin from these islands formed an important element in the commerce of the eastern world, as early as the days of Solomon.*

Samuel Rush Meyrick† infers, from the 'Triad' which celebrates Caswallan, Manawydan, and Llew-Llawgyfes as three chieftains distinguished by the possession of golden cars, that the mines of North Wales were worked by the Cymri at a very early period.

Cimboline, Prince of the Trinobantes, is known to have coined money of gold, and the probability is that this was obtained in these islands.‡ The cross of Cong, the torcs, and various gold ornaments which have been found in Ireland, and which are preserved in Dublin and elsewhere, are remarkable examples of a tolerably advanced state of manufacture amongst, in other respects, a very unsettled people, and they prove the existence of gold amongst them in considerable quantities. It is thought by those who have examined the subject with care, that the gold was all found on the slopes of the Croghan-kinsella mountain, and in those streams which have made the county of

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* Consult on this vexed question, 'History of Maritime and Inland Discovery,' by W. D. Cooley; 'Historical Survey of the Astronomy of the Ancients,' by Sir George Cornewall Lewis; 'Commerce and Navigation of the Ancients,' by W. Vincent, D.D.; 'Phœnicia,' by John Kenrich, M.A.; 'The Cassiterides: an Inquiry into the Commercial Operations of the Phœnicians in Western Europe, with particular Reference to the British Tin Trade,' by George Smith, LL.D., F.A.S. In the last quoted publication, a full and fair discussion of the whole question will be found.

† 'History and Antiquities of the County of Cardiganshire,' 1810.

‡ Sir John Pettus's 'Fodinæ Regales' supposes this gold to have been obtained in Essex. He writes, after having stated that Essex was within the region of the Trinobantes,—"This might be that mine which was afterwards discovered in Henry IV. his time in that countie." There is no evidence which would lead us to suppose that such a mine was ever discovered; but it is quite certain that this hypothetical gold mine created considerable sensation. "A letter of mandamus, issued by Henry IV., Mai ii., Anno. 2, Rol. 34, commands Walter Fitz Walter (upon information of a concealed mine of gold in Essex) to apprehend, &c., all persons that do conceal the same mine."—*Fodinæ Regales.*

Wicklow famous.* That the Romans discovered gold in England and Wales is certain. We have the statement of Tacitus already quoted, and we have the evidence of the remains of Roman mines, which were worked for gold, in several parts of the country, the most remarkable being the gold mine—Ogofau or Gogofau—near Pumpsant, in Caermarthenshire. Here, situated on the left bank of the Cothy, and forming part of the grounds of Dolau-Cothy, are the curious remains of mining, which have been well described by Mr. W. W. Smyth.† For some distance the quartz lode has been "worked open to day," and galleries and levels have been driven 170 feet through the slate. In evidence of the auriferous character of this working, are the facts that the officers of the Geological Survey discovered gold in one of the quartz lodes at Dolau-Cothy, and that a metallurgical workshop was found; and amongst other curious remains a gold necklace, which is now in the possession of Mrs. Johnes, the wife of the gentleman to whom this property belongs. Other instances might be cited, if it were necessary, in proof of the former existence of gold in tolerably large quantities in many parts of these islands.‡

The streams which were washed in ancient times were, without doubt, exhausted of their treasures by the eager searchers, and hence the reason why we find traditions of the existence of gold clinging to spots where no gold can now be found. We have witnessed, within our own time, the exhaustion of many an auriferous district in California and in Australia, and without doubt the same process went forward in this country, as has been for some years active in those distant lands. Even now the "tin streams" of Cornwall are not entirely exhausted of their gold. From the earliest period the "streamer" has carried his "quill," in which he deposits the little spangles of gold, which from time to time present themselves to his discriminating eye. These quills of gold, when filled, are sold at the nearest town. Occasionally little nuggets have been found. In the Scorrier Collection of Minerals are two as big as small beans; and examples are to be found in other private collections, in Cornwall, in the British Museum, and in the Museum of Practical Geology, in London.

There has been a constantly prevailing idea that gold mines were to be discovered in this country, and we find our monarchs, with much avarice, claiming, under the term of "Mines Royal," the right to all the precious metals which might at any time be discovered. Sir John Pettus, who was especially the agent of Prince Rupert, thus defines a "Mine Royal:" §—

"When the ore does not yield so much gold and silver as will exceed the cost of refining and the loss of the baser metal, it is called a *poor mine*. But when the ore yields gold or silver to an amount which will exceed the charge of refining and the loss of the baser ore, it is called a rich ore, or a *Mine Royal, and is appertaining to the king by his prerogative.*"

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* See a discussion on this question, 'Transactions of the Royal Geological Society of Ireland,' 11th January, 1865.

† "Note on the Gogofau or Ogofau mine, near Pumpsant, in Caermarthenshire," by W. W. Smyth, M.A. 'Memoirs of the Geological Survey of the United Kingdom of Great Britain and Ireland.'

‡ See 'Lectures on Gold,' delivered in the Museum of Practical Geology.

§ Fodinæ Regales.

A few further notes on gold seeking in the British Isles will not prove uninteresting. In 1526 James V. of Scotland granted to certain Germans the right of working, under conditions favourable to the crown royalties, the gold and silver mines of that country for forty-three years. Elizabeth had previously made similar grants to Houghsetter, Thurland, and Schutz. In neither case, however, do we learn of any gold mines having been discovered. In one part of Devonshire those miners gave the names of "Gold Street" and "Gold Field" to spots where lead and silver, but no gold, are still found; and it is probable that they worked over the valleys near North Molton, in which the Britannia and Poltimore mines are situated. A few years since these mines gave rise to poetic prospectuses, speaking, almost singing, of "Pactolean streams flowing through the lovely valleys of Devonshire," and holding out the hope of "a realization of the fable of Colchis and the Golden Fleece." In 1593 James VI. of Scotland granted "Crawford and Glengomar to Thomas Foulis, goldsmith, of Edinburgh, for twenty-one years, in consideration of the great sums due to him, by his Majesty and his dearest spouse." This grant had especial reference to the reported discovery of gold in the Lead Hills district of Lanarkshire, and it was hoped would pay off the debt, 14,594*l.*, due to the Edinburgh goldsmith. We learn, however, incidentally from another authority that "the king expended 3,000*l.* on Crawford Moor and obtained not quite three ounces of gold." Pennant, however, says, on what appears to be very questionable authority, "in the reigns of James IV. and V. of Scotland was procured in the Lead Hills from gold washed from the mountains, especially in the reign of the latter, not less than the value of 300,000*l.* sterling." We are also told that a piece of gold weighing thirty ounces was then discovered. Sir Bevis Bulmer and five other gentlemen were empowered to work all the supposed auriferous districts of Scotland, and also the silver mine of Hilderstone, near Linlithgow, which was discovered in 1607. In 1616 Atkinson, a gold refiner, obtained a grant from the Privy Council, which was confirmed by James, "to search for gold on Crawford Moor, paying the king one-tenth." The inducements which were, from time to time, held out to capitalists to embark in the great gold adventure of the Lead Hills, clearly prove the unprofitable nature of the search for gold. The most amusing—as showing how skilfully the king and Atkinson ministered to human weaknesses—was an order of council, instructing Atkinson "to move twenty-four gentlemen of England, of sufficient land, to disburse 300*l.* each," . . . . for which they were to be created for ever "*Knights of the Golden Mines.*" Again and again the cry of gold has been raised, and the result has ever been the same—renewal of a large expenditure of money, the finding of but little gold.

After the Lead Hills the most notable example of gold-seeking has been in Ireland. In 1795 gold was picked up in the valley on the flanks of Croghankinsella, and tolerably active workings were carried on by the Crown, under the direction of the Commissioners, Messrs. King, Weaver, and Middleton, until the Rebellion of 1798. The Crown during this period raised 944 ounces of gold, of the value of 3,675*l.* It was stated recently at a meeting of the Geological Society of Dublin, that a family named Byrne, who were farmers at Croghankinsella, found in the upper part of one of the rivers a mass of metal, about a pound and half in weight, which they supposed to be copper. It remained many years in their possession, and was used by them as a weight. They disposed of it at length to a travelling tinker, who carried it to Dublin, and sold it for a large price to a jeweller in Capel Street. This, or some such circumstance, led the Government to organize the commission for thoroughly examining the valleys of Wicklow. Dr. Haughton, at the meeting already referred to, said "the subject was a most interesting one, and the Society was the proper place for the discussion of it. The first point that occurred to him was the extraordinary manner in which the gold occurred in the localities referred to. The large 'model,' which had just been inspected by those present, represented a very celebrated Wicklow nugget, which some people said had been presented to George IV., but which others said that that monarch took the liberty of stealing out of this country. . . . . The peculiarity of it was that the gold appeared to consist of masses conglomerated or lumped together." This "model" represented the largest well authenticated nugget of rolled gold ever found in Europe, and which weighed twenty-two ounces.

Excellent descriptions of the Wicklow auriferous district will be found in a memoir by Mr. W. W. Smyth, which embraces also a careful examination of the mines of lead and pyrites.*

Such is a rapid outline of the history of the search for gold in the British Isles, and judging from the recorded results—these it must be admitted are few—it is not very encouraging. In nearly every case the ordinary process of washing has been alone adopted. It is true some mining works were unsuccessfully carried out in Wicklow, with the hope of discovering the quartz lodes, from which the gold was derived which had been found in the rivers. We have now to examine, with some degree of care, the progress of quartz mining, which has been carried forward for some years near Dolgelly, in Merionethshire.

In 1843 Mr. Arthur Dean discovered some rich gold ores at the Cwmheisian mines, not far from Dolgelly.† This gentleman's further researches are said "to have proved that a complete system of auriferous veins exist throughout the whole of the Snowdonian or lower Silurian formations of North Wales." Mr. Dean describes this most interesting district as consisting of an immense number of alternate parallel beds of igneous and sedimentary rocks, traversed by mineral veins and trap dykes. A valuable paper on this subject will be found in the 'Transactions of the Geological Society of London,' to which we must acknowledge our debt for much of the geological information contained in this article.* The geological relations, according to this excellent authority, are as follows:—On the north and west of the lower part of the river Mawddach lie the lower part of the Lingula flags and the Cambrian rocks. The latter consist of the coarse, thick-bedded, greenish-grey grits of Barmouth and Harlech. Their upper boundary is marked by a sinuous line, which strikes in a north-easterly direction from Barmouth to Rhaiadr-Mawddach, and from thence trends northerly a little east of Transfynydd to the turnpike road, about a mile south of Festiniog. The line then strikes S.W. to Morfa Harlech on the coast of Cardigan Bay. These grits are overlaid by that part of the lower Silurian rocks, known as the Lingula flags, which here consist mostly of blue slaty beds, generally more or less arenaceous, and partly interstratified with courses of sandstone. A well-marked portion of the series, composed of rusty ferruginous slate, occupies part of the cliffs of Moel Cynwch, that overhang Dol-fawr on the Maddach. Both Cambrian and Silurian rocks have been penetrated by numerous greenstone dykes, some of which are magnetic. The following exact description of the metalliferous district is preserved in Professor Ramsay's own words:—

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* "Smyth on the Mines of Wicklow." 'Memoirs of the Geological Survey of Great Britain.'

† "Notice respecting the Discovery of Gold Ores in Merionethshire, North Wales," by Arthur Dean, C.E. 'Report of the Meeting of the British Association for 1844.'

"Several lodes occur in this country in the neighbourhood of Dol-y-frwynog and Cwmheisian. The gold at Cwmheisian was discovered in 1843 by Mr. Arthur Dean, who, in a paper published in the 'Report of the British Association for 1844,' also stated, 'that a complete system of auriferous veins exists throughout the whole of the Snowdonian or lower Silurian formations of North Wales.' Recent events would seem, in a slight degree, to verify this bold assertion; but from that date to this time no one has heretofore attempted to work any mines in North Wales for gold, except that at Cwmheisian; nor have I ever met with any miner who has seen any gold of the alleged auriferous veins, with many of which I am also well acquainted. Cwmheisian has been worked several times, but, I believe, never with a steady profit. The gold is found in a branching lode, containing quartz with some iron pyrites. Its principal branch runs north-easterly, and is mostly composed of exceedingly hard quartz, which crosses the river about half-a-mile above Rhaiadr Mawddach. Another quartz lode, bearing lead, occurs a little above the waterfall. A north-west lead lode lies a little west of Moel-Hafod-Owen; and two others (one of them bearing silver) cross the river in the same direction, about half-a-mile below the fall. They pass through arenaceous slates and greenstone. Two north and south copper lodes cross the little valley that lies between Moel-Hafod-Owen and the hills behind Dol-y-frwynog. Two others occur on the steep slopes that overhang Afon-wen on the west, about half-a-mile south of Dol-y-frwynog. These four are in the talcose rocks above described. Several large quartz lodes traverse this country on Moel-Hafod-Owen. They are in the ordinary Lingula flags. The largest is on the east flank of the hill. The rocks are there much disturbed and altered, and numerous little bosses of greenstone are abundant among its beds.

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* 'On the Geology of the Gold-bearing District of Merionethshire, North Wales. By Professor A. C. Ramsay, F.R.S.

"When I inspected the geology of this country in the spring of 1853, the most remarkable and promising lode was the new gold lode of Dol-y-frwynog. The lode runs W.N.W. and E.S.E. in the low ground south of Moel-Hafod-Owen on the east watershed. It is principally composed of a white saccharoid quartz, irregularly traversed by numerous small loose joints. Chlorite, decomposing talcose matter, and pink carbonate of lime, are intermingled with it. In parts the quartz assumes a semi-granulated aspect, profusely intermingled with soft unctuous decomposing talc. It is largely charged with iron pyrites. As a rule, the substance of the lode is easily shivered into fragments, a great advantage both in the original working of the lode and in subsequent operations. It was first opened in search of copper; and a shaft was sunk to a depth of about twenty fathoms. During the process, however, it soon proved to contain more attractive metal. On examining a heap of quartz which lay at the mouth of the shaft, and turning over a few pieces, I readily saw, with the naked eye, gold in small flakes and grains, irregularly disseminated through the quartz. In a more select heap of quartz, on all the pieces it was distinctly visible to the unassisted eye; and one mass in particular, heavier than a strong man could lift, was literally spangled all across its surfaces with rich glittering gold. Gold has also been detected by Mr. Byers in the matrix of the copper-bearing lodes about a mile further south, and in the west of Dol-y-frwynog lode, by the spot marked 'Turf Copper Mine' on the map of the Geological Survey. All these occur in the same talcose rock.

"On the banks of the Afon-wen, about a mile above the bridge, are some ruins of buildings, and below them, close to the river, the remains of charcoal ashes and bits of bones, mostly covered with herbage. This place has a very singular, and in conjunction with its late discoveries, a very significant name, which it has maintained from time immemorial, expressive of gold having been melted or worked there.

"This name, 'Merddyn Coch'r awr,' signifies 'the ruins of red gold.' The tradition is, that the Romans formerly worked gold there. It may be well to observe, to those unacquainted with Welsh names, that no ancient place has a name but what is characteristic of its locality, or of some event that has taken place on or near the spot."

Mr. Arthur Dean was evidently the first person who called attention to the system of quartz lodes, more or less auriferous, which have rendered this district remarkable. It is said, however, that a little gold was detected in one of the copper ore lodes in the year 1836. Of late Mr. Dean has been appointed engineer to the Vigra and Clogau mines, and this position has enabled him to study with much care the peculiar conditions under which the gold occurs in these quartz veins. These are especially deserving of the closest study—they are the only gold bearing rocks of this country—and the workings which are now in progress present opportunities which should not be neglected. Within an ellipse about fifteen miles long by twelve miles wide, are enclosed all the mines opened in the Dolgelly district. Outside this, other fields are found, the most promising being the Bala district, in which is situated the Castele Carn Dochan gold mine, which is now yielding, monthly, small quantities of gold. Nearly all the gold mines are opened in the lower Silurian beds, but in the Cambrian sandstones some of the quartz veins produce gold. The presence of greenstone or trap rocks has been already noticed;

and it is a fact deserving of note, that away from the vicinity of those rocks, no good gold lode has been discovered.

The most important gold mines in North Wales are the Vigra and Clogau, from which, as we stated in our Chronicles of Mining in our July number, 10,778 ounces of gold had been obtained to the end of 1864. For some years, both the Vigra and the Clogau mines were worked for copper. They are now united as auriferous quartz mines, but nearly all, if not all the gold, has been obtained from the latter.

The Clogau St. David, No. 1 mine, is certainly the richest gold mine ever worked in the British Islands, and may compare favourably with the quartz reef mines of Australia. According to Mr. Dean, from a space of ground not more than fifty fathoms long by thirty fathoms deep, and only a portion of which has been worked away, there had been extracted at the 31st of May last, and reduced 4,154 tons of quartz, yielding 11,508 ounces of gold, giving an average of 2 oz. 15 dwts. 19 grs. per ton. Taking this lode as a type of those which occur in its neighbourhood, it will be well to describe it.

The lode has an average bearing 15° N.E., and is intersected by a very powerful cross-course, bearing 30° N.W., and dipping slightly S.W. The lode traverses beds of indurated Silurian clay slate, which are interstratified with thick beds of greenstone. There is also a large greenstone dyke, which is traversed by a portion of the lode for a length of about sixty fathoms, until they are intersected by a great cross-course. Behind this cross-course the lode is extremely rich in gold. It should be stated that the lode is composed almost entirely of quartz, with here and there some carbonate of lime. Throughout the quartz, yellow copper ore is, in small quantities, disseminated as well as gold. Where the gold is most abundant, Telluric Bismuth in fine silvery white grains is generally present, and an opinion prevails that whenever that mineral is met with, gold is near at hand. It was commonly supposed that gold is only to be found near the surface. Mr. A. Dean has favoured us with some notes on this point, which are exceedingly important if all the conditions have been correctly observed. Without comment, Mr. Dean's own words are given:—

> "The opaque white quartz floors, which are comparatively poor in gold, alternate with others of a greenish white colour, very dense, and of a shining conchoidal fracture; the latter are the rich gold-bearing floors; we have, therefore, alternate rich and poor floors. From the dip of the floors the deposits of gold appear individually to dip eastward, but, as the bands of clay-slate forming the walls of the lode below the greenstone dip westward down to the cross-course, the succession of bunches of gold in the alternate floors of greenish quartz follow the dip of the clay-slate. This is an important point in relation to the recurrence of rich deposits of gold in depth below the present bottom."

This quotation sufficiently indicates the hypothesis that with a recurrence of the same conditions in depth, rich, or perhaps richer, deposits of gold may be met with. There is a very close analogy between gold and tin. It was an opinion, held with much obstinacy for a long period, that tin would never be found deep in the earth. Experience has now proved the fallacy of this, for the most abundant deposits of tin are now worked at depths of between 200 fathoms and 300 fathoms from the surface. The result of sinking on the quartz lodes in the mountains of Merionethshire will be watched with much interest.

Invariably when a good mine is discovered, a great many other mines are started in the neighbourhood. This applies to every variety of mine exploration, and is especially applicable to gold-mining. Numerous attempts and failures have hitherto marked the progress of mine-adventure in North Wales; and it is generally believed that more gold has been expended on the Welsh hills than has been obtained from them. The authority whom we have already quoted, speaking of the poorer varieties of quartz, says:—"The Clogau Company has stamped 2,500 tons of poor ores, yielding an average of 12 dwts. per ton; and during the last two months the Castele Carn Dochan Company has stamped 200 tons of the mineral broken indiscriminately from their lode, with an average of 15 dwts. of gold per ton. With good reduction machinery several of the gold mines in the Dogelly district might yet be made to pay." It will be most satisfactory to find the hopes thus expressed by Mr. Dean fully realized. It is right that some idea should be given of the occasional richness of this auriferous quartz. Mr. T. A. Readwin informs us* that by far the richest discoveries of gold have been made at the Dol-y-frwynog, Prince of Wales, and the Clogau Mines. He has, he states, extracted gold from stones, from each of those mines, at the rate of 300 to 400 ounces to the ton. At the same time as he draws attention to the exceeding richness of some specimens of the auriferous quartz, Mr. Readwin says, with much honesty, "I beg distinctly to state that the average yield will not, in my opinion, exceed half-an-ounce to the ton of ore."

Our readers will be familiar with the amalgamating process, by which gold is separated from the earthy minerals with which it is mixed. The extraction of gold by amalgamation is, however, attended with serious difficulties. Whenever Sulphides, Arsenic, Bismuth, or Tellurium are present with the gold, they frequently tarnish the metal, and the mercury cannot act upon it. Technical language informs us, that the mercury "sickens," that is, it grows thick, or that it "flours," meaning that it becomes pulverulent. These conditions are dependent upon the presence of other metals. Under either of those circumstances much of the gold escapes the influence of the mercury and is lost in the "tailings," whilst much of the mercury itself is carried off in the washings. Mr. William Crookes, F.R.S., the discoverer of the new metal Thallium, has introduced an improvement, which promises to be of the utmost advantage, in all our operations for obtaining gold in quartz-mining, or when it is combined with other minerals.

Mr. Crookes's process possesses the following important advantages:—By the judicious admixture of a certain proportion of Sodium with the mercury its amalgamating powers are, under all circumstances, preserved and intensified. It will extract gold from Sulphides, and from such other minerals as have hitherto resisted the ordinary process. It will seize upon gold tarnished by any of the metals named above, and which would pass untouched through common mercury and be lost. It will absolutely prevent "sickening" and "flouring," consequently the yield of gold is augmented, and a large saving in mercury is the result.

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* "On the recent Discovery of Gold in Merionethshire." By T. A. Readwin, F.G.S. 'British Association Reports for 1863.'

A series of experiments were made to determine the action of the sodium, under such circumstances as presented unusual difficulties, and the results of these trials were as follows:—

It should be stated that the mercury contained one per cent. of sodium.

1. When a little of the sodium amalgam was added to ordinary mercury, the affinity of the latter for gold was greatly increased, so that when pieces of gold were dipped into it they were instantly covered with mercury, although when dipped into mercury to which no sodium had been added, amalgamation was very slow, and difficult to obtain.

2. "Floured" mercury immediately ran together into a single globule, on the addition of a little sodium amalgam.

3. When iron pyrites (bisulphuret of iron), magnetic iron pyrites (sulphuret of iron), or copper pyrites (sulphuret of copper and iron), were triturated with sodium amalgam, the pyrites were decomposed, and on the addition of water, a black precipitate of sulphuret of iron was obtained.

4. Triturated with sodium amalgam—*a*, Arsenical pyrites was decomposed and arsenic amalgam formed; *b*, Galena (sulphuret of lead) was decomposed, and lead amalgam formed; *c*, Blende (sulphuret of zinc) was decomposed and zinc amalgam formed; *d*, Litharge (oxide of lead) and white lead (carbonate of lead) were decomposed and lead amalgam formed. An extensive series of experiments has been made at the mines near Dolgelly, and in every case, a considerable increase in the quantity of gold has been effected by the use of the sodium amalgam. The only thing which appears to be necessary to ensure the usefulness of the sodium amalgam in all cases, is a preliminary experiment to determine the quantity of sodium which should be used with the mercury. When too much sodium is employed it attracts the other metals present—in some cases to the rejection of the gold; but when judiciously applied it works with wonderful facility.* This discovery promises many advantages to the adventurers in the auriferous mines of Wales, and it will probably lead to the successful working of some of the poor quartz lodes through which the sulphides and arsenides of the baser metals are disseminated, and thus prove a solution of the problem, Can British gold be worked with commercial advantage?

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* Since the above experiments were tried, Mr. Crookes has introduced a modification into his process, by which the ill effects of adding an excess of sodium are entirely avoided. The improved process has been thoroughly examined and experimented on by Dr. W. Allen Miller and other high authorities, and the results are said to be very striking.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

Professor Church, of the Royal Agricultural College, has published the results of some experiments instituted to ascertain whether the denser grains of wheat will yield a larger and better crop. The conclusions indicated were that seed wheat of the greatest density produces the densest seed and the largest amount of dressed corn; that seed wheat of a medium density generally gives the largest number of ears, but the ears are poorer than those of the densest seed; that seed wheat of medium density generally produces the largest number of fruiting plants; and that seed wheat which sinks in water, but floats in a solution having the density of 1·247, is of a very low value, yielding on an average only 34·4 pounds of dressed corn for every 100 yielded by the densest seed. These were the results given by experimental plots, in each of which twenty seeds properly selected had been planted. It also appears, from experiments on a larger scale, over plots of twenty to forty perches apiece, that an average return of about 13*s.* per acre is obtainable by submitting the seed sown to a process which shall separate from it the lighter corns; that a very high standard of density is not required to secure this extra return, the exclusion of about one-fifth of the ordinary seed corn being probably sufficient; and that the process of selection of seed in this way, according to density, is easy and inexpensive. On the whole of this series of experiments and their results, it is sufficient to remark that a single inquiry of this kind is altogether inadequate to determine or eliminate the really efficient agent or cause of the results that were obtained. And even supposing this not to be external, but to be resident in the seed itself that was selected with so much care, yet the density of the grain is most likely not the cause, but the mere concomitant of the cause, to which the results are properly attributable. It seems plain that the general character and habit of growth of a plant is to some extent inherited from the past and transferable to the future generation of it; but it is not so easy to believe that any such quality as density of seed is inherited or transferable. Such a quality must be due to the nutrition of the plant, by both soil and air, throughout the several stages of its growth, long after it has parted with the original mother-seed. And the farmer who knows how a heavy, starch-filled, full-sized berry, and a lean, horny, shrivelled sample of grain at harvest time are often both of them obtained from the very same seed corn—according to the quantity of seed he sows per acre, the condition of the field, and the circumstances of the weather during July and August—who therefore knows what are the principal and all-powerful agents in the production of a good sample of whatever sort he grows—will value at a very low rate that influence exerted by the density of individual seed corns, which, all other things being equal, may perhaps to some small extent be readable in the crop at harvest time.

Mr. Lawes, of Rothamsted, has reported in the Royal Agricultural Society's Journal, an attempt made to reproduce upon his farm the alleged experience of M. Hooibrenk in the artificial fertilization of wheat. That gentleman had declared in the *Journal d'Agriculture Pratique* that he had obtained a largely increased crop of wheat by an artificial fecundation of the plant conducted in the roughest possible manner. That this process is capable of being artificially directed is plain from the success of experiments in hybridising. If we cut out the anthers of one flower before the pollen has escaped, and substitute others full and just ready to burst, we ensure an artificial result. But the process is one of extreme delicacy, and needs to be most carefully executed. M. Hooibrenk's plan was, on the contrary, extremely rude. To a rope long enough to stretch across the plot to be operated on, pieces of woollen twist two feet in length are attached so close as to touch each other, thus forming a fringe two feet deep. Before using it, this fringe is smeared with honey, and the rope thus prepared is stretched across the plot, and trailed over the growing crop when in bloom in still weather. The idea is that the natural process of fertilization is often imperfectly accomplished, and that by this artificial contrivance an efficient aid is rendered which will make itself apparent in the crop. Mr. Lawes did not find it so. He had plots of land whose cultivation and produce had been so exactly recorded for twelve years, that he was certain of identical results from them under uniform treatment; but no results were perceptible from the adoption of M. Hooibrenk's process, even on such land where they would certainly have been seen. The honeyed fringe was drawn over each plot to be operated on, three times at intervals of forty-eight hours early in July, and the following table gives the produce obtained with and without the process of artificial fecundation.

Produce of Wheat per Acre on Duplicate Plots, one Artificially Fecundated and the other not. Harvest 1864.

Plots, &c.	Dressed Corn.			Offal Corn.	Total Corn.	Straw (and Chaff).	Total Produce (Corn and Straw).
	Quantity.		Weight per Bushel.				
	bs.	pk.	lbs.	lbs.	lbs.	lbs.	lbs.
12*a* Artificially Fecundated . .	44	1¾	62.6	99	2881	4315	7196
12*b* Not " . .	44	3	62.4	93	2882	4356	7238
Difference	0	1¼	0.2	6	1	41	42
13*a* Artificially Fecundated . .	42	2¾	63.2	88	2786	4480	7266
13*b* Not " . .	43	2¾	63.4	111	2882	4620	7502
Difference	1	0	0.2	23	96	140	236
14*a* Artificially Fecundated . .	41	0¼	63 1	149	2740	4003	6743
14*b* Not " . .	41	3¾	62.8	110	2745	4107	6852
Difference	0	3½	0.3	39	5	104	109

In none of the trials was any increase of produce obtained by means of the fecundating process. Mr. Lawes very reasonably adds— "It may be remarked that it would seem our neighbours, the French agriculturists, are now going through a stage which in this country was passed through some few years ago. The artificial application of electricity, seed-steeping, and other marvels, which were to double the produce of our fields at little cost, have had their day with us; but the British farmer is still toiling on as formerly, earning his bread by the sweat of his brow and the liberal use of manure, without which he does not find his crops increase."

That the conditions under which the process of natural fecundation is effected do influence the productiveness of the crop, is almost every harvest plainly shown; but that any such rough and wholesale attempt at artificial assistance can be efficient is clearly impossible. The produce of grain crops at harvest time is, however, even more dependent on the weather and the soil throughout the other months of the plant life, than it is on such variations of weather as we suffer during July when they are in bloom; and thus, though we had a wonderfully fine latter end of June and commencement of July this year, during which the process of fecundation must have been most perfectly accomplished, the produce of our corn-fields is this year greatly deficient. A dry spring time, and one or two cold days in early June, seem to have made all light-land crops, and very generally the spring-sown crops on all sorts of land, deficient.

The 'Agricultural Gazette' has published the returns from its correspondents in the following terms:—

"Wheats on the lighter soils and loams are generally inferior, Barley on the lighter and thinner barley soils is much below an average, and, though probably the best crop of the year, it, too, as a whole, is inferior. Oats, excepting the few instances where winter sown, are the poorest crop we have had for many years. Beans and peas are generally below their usual yield."

The following is a tabular statement of the Returns:—

Number of Returns.

Crops.	Under Average.	Average.	Over Average.	Total.
Wheat . . .	76	90	29	195
Barley . . .	40	112	28	180
Oats . . .	154	27	2	183
Beans . . .	64	58	4	126
Peas . . .	37	67	6	110

The exceptions to the general failure are in the case of clay land wheats, and notably in that of wheats on the poorer clays, which is almost everywhere unusually good. The barley on the better class of barley soils is also a fair crop wherever early sown. Peas are a good crop in some districts.

The root crop is a great improvement through all southern and midland England over that of last year. Mangels are generally good, and

Swedes and other turnips are tolerably promising. In the North, and all over Yorkshire and Northumberland, they have, however, been destroyed by the grub. And there has been, especially in the cotswold country, an extraordinary abundance of the common earwig in the field, to which the failure of the turnip crop is in some places attributed.

Certainly the annual results of farm management can as properly claim a record in a scientific journal, as the methods and the circumstances to which they are due. Whether in the vegetable or animal world, they are the truest test and touchstone of what is sound or unsound in those scientific discussions upon agriculture which might seem to claim precedence here. It is on the farmer's own experience, after all, that he must depend for guidance, and not upon the teachings, however confident and unquestionable, of the man of science, absolutely correct though these may be under certain limited conditions, not those perhaps of the field or of the homestead on which the experience of the agriculturist depends. Thus it was, that when Mr. Chadwick, at the discussion some months ago before the Society of Arts, declared his preference of the views of chemists and sanitary philosophers and engineers and gardeners, to those of farmers, on the agricultural utilization of town sewage, he was very properly met by a vigorous assertion of the absolute sovereignty of agricultural experience in the decision of all agricultural questions; and Baron Liebig's declaration of the intrinsic worth of guano for plant growing, as being under 8*l.* per ton, was quoted as an illustration of the folly of any other guidance. Is guano, because so the chemist says, therefore worth rather less than 8*l.* per ton? No, it is worth rather more than 12*l.* a ton. This indeed Liebig called a 'fancy' price. On the contrary, it is the *real* price, as any one going into the guano market will find. Agricultural experience of guano during twenty years of a trade exceeding 1,000,000*l.* per annum, and over an acreage probably exceeding 1,000 square miles every year, has determined its real value to the farmer past all power of chemical authority to upset it: and it is this, not the opinion of the purely scientific man, which affords the only trustworthy agricultural guidance to the farmer.

We are now on the point of an attempt, on a very large scale, on the part of agriculturists to realize somewhat of the value which chemists tell us that town sewage possesses. The Metropolitan Sewage Company has been fairly launched, and will proceed at once to carry out its plans for enclosing the Maplin Sands from the sea, and for conveying London sewage thither; and we shall in a very few years know certainly all that living plants, upon the scale of agriculture, and under the circumstances of South Essex soils and climate can tell us of the real, as distinguished from the 'fancy' price which the great German chemist puts on diluted town drainage.

The Cattle Plague.—The statistics of agriculture are of the same commercial and practical, as well as scientific interest, with regard to the live stock portion of the farmer's property, as they possess in respect of his corn fields. This branch of the subject is indeed of especial interest now. The price of butcher's meat is unprecedented. It is probably chiefly due to the small produce of cattle food which last year's climate gave us. There was little hay and hardly any roots, and the raw material of the meat manufacture being scarce, the quantity of the manufactured article is proportionably small and its price proportionably high. But we have now among us a contagious disease, which is destroying large numbers of beasts, and there is every prospect consequently of meat becoming even scarcer. The Russian rinderpest, imported early in June, has found in the London cowhouses and in many cowsheds elsewhere, circumstances under which its poison, rapidly spreading, is extremely destructive. But it is not confined to close and badly ventilated buildings, for in country districts—Hampshire, Sussex, Kent, Essex, Norfolk, Shropshire, and elsewhere—we hear of its occurrence and fatality where cattle have been grazing in the open meadows. It is almost always traceable to stock bought in the London market, which has brought the infection with it into the country. It is an extremely virulent and infectious bovine typhus, which has hitherto completely foiled all attempts at treatment.

The principal endeavour therefore seems to be to isolate the evil, and by the destruction and burial of cattle when once they are attacked, to kill the poison before it has had time to spread. There has thus been less opportunity for the treatment of the disease than is desirable. Orders in council have given power to veterinary inspectors to direct the destruction of infected cattle, and attempts have been made to isolate particular districts, by hindering transportation and by regulating sales. Altogether untouched by these arrangements, however, there can be no more fruitful source of contagion than town dung from infected cowhouses, which is widely distributed by railway and canal. And so subtle is the mischief, that animals not themselves liable to the disease, both sheep and men, it is said, can convey the virus from diseased to healthy stock by contact, first with the one, and then, even at a considerable interval of time, with the other.

Another attack of contagious disease occurred during July and August on a farm in Sussex, where a flock of sheep became infected with the ovine small-pox; but here the prompt destruction of the infected animals and complete isolation of the farm has been successful in hindering the spread of the malady, which seems to have at length died out. It is to be hoped that similar measures, vigorously taken with reference to the rinderpest, may be similarly successful, notwithstanding that its occurrence in quick succession in so many different localities greatly increases the difficulty of the task.

The Society of Arts have published a report on the cottage building question, which, although its subject is treated as especially affecting labourers in towns, must yet be noticed in our agricultural chronicle. They have not considered it necessary to collect proofs of the existing unfitness of the greater part of the dwellings of labouring men as habitations for respectable and well-conducted families, nor have they thought that any further proof was needed that the excessive overcrowding which now exists in such dwellings promotes crime and immorality, harbours disease, and materially lessens the effective power of the working classes by injuring health and shortening life. Considering all these, and many other equally important facts as already sufficiently proved, the Society discussed the practical difficulties in the way of an adequate provision of good house accommodation on terms within the reach of the labourer's means. On one point in particular, which relates especially to cottages in country districts, the Society very properly declare that the alternative of charging the relief of the pauper on the parish or on the union in which he resides, is one which peculiarly affects the building of cottages in the country. The present system has long been found one of the greatest obstacles to the proper accommodation of labourers on the estates on which they work; and the Society were prepared to recommend an amendment of the law by the extension of the chargeability of the poor from the parish to the union. The same views on this important question have been, however, generally recognized by the Legislature, and it is probable from the course of recent legislation that they will be still further carried into operation.

With this exception most of the topics which came under the attention of the Society affect rather working men in towns than rural labourers, and we do not therefore quote at length those paragraphs in the report which relate to demolition of houses by railways, to workmen's trains, and to enforcing the sanitary laws. The following shortly are the results of their deliberations. They recommend:—

1. That corporations, limited owners, &c., should have increased power to sell land for the erection of dwellings for labourers, under conditions as to proper drainage, ventilation, and sanitary regulations.
2. That the public loan commissioners should be authorized to lend money, at a rate not exceeding 3½ per cent. per annum, for building dwellings for the labouring classes, under suitable guarantees and with due regard to sanitary arrangements.
3. That in all future railway acts, and acts for local improvements, when houses inhabited by the working classes are destroyed under compulsory powers, such companies should be compelled to provide, within a convenient distance, other dwellings in lieu of those destroyed.
4. That the following amendments should be made in our sanitary laws:—
    - *a.* That the appointment of inspectors of nuisances throughout the country should be compulsory.
    - *b.* That increased power be given to the proper local authorities, to oblige builders of houses to provide adequate drainage and ventilation.
    - *c.* That the medical officers of health should be irremovable without the consent of the Privy Council, and that the amount of their salaries should be subject to the approval of the same authority.
    - *d.* That houses in which lodgers are taken, especially where particular rooms in a house are overcrowded, should be brought under more efficient inspection.

II. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

Attention has been again directed to the value which will accrue to Astronomical Science by an Arctic expedition to the Southern Pole, in preparation for the astronomical observations which will have to be undertaken in the year 1882, on the transit of Venus, the most favourable of all phenomena for solution of the noble problem of determining the sun's distance from the earth, provided that proper stations for the observation can be found. The Astronomer Royal has written a letter to Sir R. I. Murchison, President of the Royal Geographical Society, in which, referring to the late discussions at the Geographical Society in reference to a proposal for an expedition towards the North Pole, the author states that though there is no single point of great importance to be obtained, there are a number of co-ordinate objects whose aggregate would be valuable. Professor Airy then suggests that the field is open for another proposal, which would give opportunity for the determination of various results, corresponding in kind and in importance to those of the proposed northern expedition, though in a different locality, and would also give information on a point of great importance to Astronomy, which must be sought within a few years, and which it is desirable to obtain as early as possible.

In our last volume we gave several extracts from an elaborate paper by the Astronomer Royal, in which he very carefully discussed the circumstances of the coming transit, in reference to the selection of observation-stations. For the northern stations there will be no difficulty; they will be on the Atlantic seaboard of North America, or at Bermuda; all very favourable and very accessible. For the southern stations the selection is not so easy; the observation must be made on the Antarctic Continent; if proper localities can be found there, and if the circumstances of weather, &c., are favourable, the determination will be excellent; if those favourable circumstances do not hold, no use whatever can be made of the transit.

The Astronomical object of a Southern expedition has already been sufficiently explained in these Chronicles. In the event of such an expedition being undertaken, the precise determinations which have been indicated as bearing on the astronomical question must (from the nature of the case) take precedence of all others. But there would be no difficulty in combining with them any other inquiries, of Geography, Geology, Hydrography, Magnetism, Meteorology, Natural History, or any other subject for which the localities are suitable.

The author concludes his letter by requesting that Sir R. I. Murchison will communicate these remarks to the Royal Geographical Society, and take the sense of the Society on the question, whether it is not desirable, if other scientific bodies should co-operate, that a representation be made by the Royal Geographical Society to her Majesty's government on the advantage of making such a reconnaissance of the Southern Continent as has been proposed; primarily in the interest of Astronomy (referring to his official responsibility for the importance of the examination at this special time); but conjointly with that, in the interests, perhaps ultimately more important, of geography and other sciences usually promoted by the Royal Geographical Society.

A most valuable contribution to astronomical photography has been made by Lewis M. Rutherfurd to the American 'Journal of Science.' He at first employed a reflecting telescope with a silvered mirror, but after numerous trials he was obliged to abandon the instrument, owing to several difficulties inherent in the employment of this kind of telescope. He has now constructed an object-glass, not achromatic as regards colour, but corrected solely with reference to the photographic rays. The correction of this has been rendered certain and tolerably simple by the employment of the spectroscope as a means of examining its achromatic condition.

The image of a star at the focus of a perfectly corrected objective would be a point, the apex of all conceivable cones having the object glass, or parts of it, as the bases. This point falling upon a prism would be converted into a line, red at one end and violet at the other, with the intermediate colours in their proper places. If, however, the different coloured rays are not all brought to the same focus, the spectrum will no longer be a line, but the uncorrected colours will be expanded to a brush, the width of which will be the diameter of the cone where intercepted by the prism. It will thus be seen that a simple glance at a star spectrum will indicate at once what parts of the spectrum are bounded by parallel lines and consequently converged to one focal point, and what parts do not conform to this condition, and also the amount of divergence.

On applying this test, it was found that an objective of flint and crown, in which the visual was united with the photographic focus (in other words, where the instrument could be focalized on a plate of ground glass by the eye, as in ordinary cameras), was a mere compromise to convenience, in which both the visual and actinic qualities were sacrificed.

In order to bring the actinic portion of the spectrum between parallel borders, *i. e.* to one focus, it is necessary that a given crown lens should be combined with a flint which will produce a combined focal length about one-tenth shorter than would be required to satisfy the conditions of achromatism for the eye, and in this condition the objective is entirely worthless for vision.

Having obtained the achromatic correction, the most delicate task was to produce the correction for figure, since the judgment of the eye was useless unless entirely protected from the influence of all but the actinic rays. A cell of glass, enclosing a sufficient thickness of cupro-sulphate of ammonia, held between the eye and the eye-piece, enabled the author to work for coarse corrections upon α Lyræ and Sirius, but so darkened the expanded disc of a star in and out of focus that all the final corrections were made upon tests by photography, which gave permanent record of all the irregularities of surface to be combated. Still, however, the process was long and tedious, dependent upon but three stars as tests, and they too often obscured by bad weather. The mode of correction was almost entirely of a local nature, such as practised by the late Mr. Fitz and Mr. Clark for many years.

The objective was completed about December last, and the corrections of it are such that it is thought to be capable of depicting any object as seen, provided there be sufficient light, and no atmospheric obstacles. As respects the light; the objective has given photographic images of stars, designated by Smyth as of the 8½ magnitude, and other stars on the same plate of full a magnitude lower. In the cluster Prœsepe, within the space of one degree square twenty-three stars was taken, many of which are of the ninth magnitude, with an exposure of three minutes. An exposure of one second gives a strong impression of Castor, and the smaller star is quite visible with half a second. With an achromatic objective it was necessary to expose Castor ten seconds to obtain a satisfactory result.

The great obstacle which prevents the results of photography from realizing the achievements of vision is atmospheric disturbance. In looking at an object the impression is formed from the revelations of the best moments, and it is often the case that the eye can clearly detect the duplicity of a star, although the whole object is dancing and oscillating over a space greater than its distance. The photograph possesses no such power of accommodation, and the image is a mean of all the conditions during exposure. It is, therefore, only on rare nights in our climate that the picture will approach the revelations of the eye.

Up to the date of the author's paper only one night had occurred with a fine atmosphere, and on that occasion the instrument was occupied with the moon; the negatives were described by the author as being remarkably fine, and superior in sharpness to any he had yet seen. The exposure for the phase three days after the first quarter is from two to three seconds, and for the full moon about a quarter of a second. Its powers have not yet been tested upon the close double stars, 2″ being the nearest pair it has been tried upon. This distance is quite manageable, provided the stars are of nearly equal magnitude. The power to obtain images of the ninth magnitude stars with so moderate an aperture, promises to develop and increase the application of photography to the mapping of the sidereal heavens, and in some measure to realize the hopes which have so long been deferred and disappointed.

It would not be difficult to arrange a camera-box capable of exposing a surface sufficient to obtain a map of two degrees square, and with instruments of large aperture we may hope to reach much smaller stars than have yet been taken. There is also every probability that the chemistry of photography will be very much improved, and more sensitive methods devised.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

Professor Wolf has presented a paper on the course of the sun-spot phenomenon, in which he discusses the statements made by himself and other observers as to the relation in which sun spots stand to the planets. In 1859, when he sought by means of a formula dependent on the periods and masses of the four planets *Venus*, *Earth*, *Jupiter*, and *Saturn*, to represent a curve analogous to the sun-spot curve, he stated that Jupiter determines the leading character of the Sun-spot curve, that Saturn causes small alterations in the height and length of the undulations, and that the Earth and Venus determine the indentations of the curve.

As subsequent observers have drawn attention to the connection between sun-spots and planets, especially Jupiter and Venus, Professor Wolf has in this paper given some statements as to the connection between the sun-spot period and the revolution of Jupiter. A table is given in which it is seen that the period 11·11 completely satisfies what is only to be expected from a mean period affected with the considerable oscillation, 1·75; and not only there corresponds to the mean course thereof a good wave line with the difference, 42·96, between maximum and minimum, but the single maxima and minima accord well together, with only a slight displacement of the minimum of 1783 and the maximum of 1786.

A new arrangement of two solar prisms for use with a micrometer has been described by the Reverend W. R. Dawes. The transparent glass diagonal, suggested by Sir J. Herschel, is a very valuable adjunct in observations where it is desired to determine the relative situations of solar spots by means of a micrometer, as it permits a large aperture to be employed without danger to the dark glasses. But a very considerable difficulty arises from the fact that the relative positions of the spots and of the points of the compass, as thus seen, are different from their positions as they appear in the astronomical refractor. To remedy this inconvenience, Mr. Dawes has been in the habit of combining *two* pieces, each of which had a transparent glass diagonal, capable of being used separately or together. By this simple contrivance the image as reflected from both the combined prisms is seen in the direction of the axis of the telescope, and its various parts are in the same relative positions as when no diagonal is used.

At the June meeting of the Society, Mr. Dawes also gave a paper on the planet Mars, in which numerous curious and interesting features were described, such as the long, narrow strait, running N.E. and S.W. in the northern hemisphere; an oval bay with a regular coast, in which lately a distinctly forked appearance was noticed, giving the impression of two very wide mouths of a river which, however, he could never trace. Speaking of the colour, the author considers that nothing can more fully prove that the ruddy tint of Mars does not arise from any peculiarity in the colour of the planet's atmosphere, than the fact that the redness is always deepest near the centre, where the atmospheric stratum is thinnest; while near the edge of the planet the grey features are obscured, and in general entirely hidden, by the density of the atmosphere, and yet the colour reflected from it is *white*, or *greenish-white*. The greenish tinge may possibly arise from contrast with the ruddy centre.

On the whole, the impression appears to be, that Mars has not usually a very cloudy atmosphere. During the last opposition the permanence and nearly equable distinctness of the principal features under similar circumstances was surprising. On no occasion could Mr. Dawes satisfactorily make out that any part was decidedly less distinct than might be expected from the appearance of the other features then visible.

Another paper by Mr. Dawes was on an aperture-diminishing eye-piece and a photometer of neutral tint glass. By the former arrangement the aperture of the object glass can be virtually diminished to any desirable extent without disturbing the telescope to vary the aperture on the object glass. The great convenience of this arrangement is too obvious to need further comment.

The other photometric arrangement consists in the addition to the solar eye-piece of one or more sliding wedges of neutral-tint glass; the obscuration extending from the smallest possible to what is usually sufficient for the Sun. A capital advantage of this arrangement is, that the small apertures in the diaphragm of the solar eye-piece enable one of the components of a double star to be excluded from the field while the brightness of the other is measured:—obviously a very necessary precaution where the stars differ greatly in brightness. As an example, it may be stated that the very small star near *α Lyræ* appears, when the large star is in the field with it, to be about of mag. 11·2 of Struve's scale; but, on excluding the large star, it rises to about 9·7, a difference of 1½ magnitude. In the same way the comparative brightness of different portions of the Moon may be determined by isolating them in a small field. Thus also the brightness of the solar illumination of our atmosphere may be compared with that of the photosphere of the Sun itself, and also different parts of the photosphere.

Some good observations on the photosphere of the sun have been communicated by Mr. Fletcher. He comes to the conclusion that the appearance of the interlacing of long, flat, lenticular-shaped objects is due to a tremulous atmosphere, for the moment the atmosphere became steady the appearance vanished; and when vision was most perfect the idea of interlacing could not be entertained. The result of this examination of the sun's disc with an instrument of unexcelled defining power and under atmospheric circumstances such as rarely occur, is a strong impression that the granules are not "entities" at all, but portions of the sun's luminous envelope raised high in the outer and non-luminous atmosphere.

Some very elaborate observations on the solar photosphere and sun-spots follow by Mr. Brodie and Mr. Lockyer. Each of these papers is illustrated with woodcuts. The former gentleman's observations appear to show that the *rice-grains* and *willow-leaves* must not be confounded with each other, as (according to Mr. Nasmyth's measurements) the latter must be about thirty times smaller than the former; on some occasions the outlines of some of the elevations were so clearly and sharply defined, that they could be compared to the appearance of a *coarse shingle beach.* During an examination of the sun through a red haze, which was found extremely favourable to definition, a number of the rice-grain forms were noticed lying in various directions one with another; the length of some of them being estimated at 8″ or 10″ and about 2′ in width. These waves, or ridges of photospheric cloud, were not of equal elevation throughout their entire length, but seemed to have an irregular outline of elevation, such as a cumulous cloud generally presents, so that the top of the very wave, or ridge, that causes the mottled appearance on the sun was itself most irregular in the outline of its upper surface. The sides of these waves, or ridges were of very great inclination, not very greatly removed from the perpendicular; the indentations, or valleys, between them intersecting each other most irregularly. In some parts of the photosphere, where the rounder forms prevailed, the indentations seemed very deep, and penetrated the cloudy stratum in such a slanting position, that the bottom of them could not be seen. These indentations seemed to be *at least* 2″ in depth, or 1,000 miles, but the estimation of their profundity is a difficult matter. The tops of the ridges were the brightest, while the valleys, or indentations, appeared somewhat shaded and less luminous. On some occasions these were noticed, speckled with black dots, or pores. The whole of this mottled surface seems to be disposed in the form of huge undulations, very similar to ranges of mountains, as shown on a good map; the elevated portions appearing as *minute faculæ*, but far smaller, and far more difficult to observe, than the ordinary faculæ of the Sun.

Mr. Brodie has given an interesting account of the progress of an unusually wide bridge of luminous matter, which formed completely across a large oval-shaped spot, in the course of a few hours, showing the extreme mobility of the sun's photosphere. The luminous matter which formed the bridge, must have moved at the enormous velocity of 14,000 miles per hour. Mr. Brodie concludes, that from what he has observed of the Sun's surface, he cannot conceive the possibility of any regular form of particles so interlacing themselves together as to form the wonderful *nodosity* of the photosphere of the Sun, since any such interlacing would apparently necessitate a *comparative evenness and uniformity of surface*, and so far as he has been able hitherto to see the peculiar formation of the Sun's envelope, he has been as unable to reconcile the *willow-leaf theory* with it.

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Mr. Lockyer's observations are devoted to one spot, which appears to have been remarkable in several respects; at one part a bright tongue of facula stretched out into the umbra, in the centre were what appeared to be clouds, which after a time appeared to condense into willow leaves; at another side was a promontory, in which the willow leaves were changing the direction of their larger axes, with respect to the centre of the spot, whilst in another part, the penumbra seemed composed of layers, and the willow leaves were arranged like feathers on a duck's wing. Mr. Lockyer quotes the following paragraph from a letter recently published by M. Chacornac:—

"Having had the occasion formerly to observe small pieces of silver bathed in borax, melting under the influence of the blowpipe, I have always in my descriptions compared the 'crystals' of the photospheric matter to this silver solder in a state of fusion. Of the same opinion as Mr. Dawes, I hold that 'straws' at present are the objects which give the best idea of the appearance of the objects of which the whole solar photosphere consists. On the other hand, I do not find that in the many notes, and especially in those of Father Secchi, containing observations of this nature, is mention made of any important phenomena presented by these incandescent 'willow-leaves' or 'rice-grains.' As it is inherent in the nature of this matter, I will endeavour, as concisely as possible, to state in what it consists. If we observe a 'crystal' of photospheric matter, which is completely isolated and projected on a dark portion of a spot, for instance, it will be seen that for a certain time it diminishes in volume and becomes spotted over with small dark pores; that it is subdivided into numerous crystals, as if the photospheric matter were being volatilized, or as if there were a reabsorption going on, absolutely in the same way as crystals of sugar melt under a current of steam."

III. BOTANY AND VEGETABLE PHYSIOLOGY.

(*Including brief Notices of recent Botanical Works.*)

Casimir de Candolle has investigated the theory of a single angle of Phyllotaxis, or leaf-arrangement. He considers the views of Schimper, Bravais, and Martins, and afterwards endeavours to show that the single angle will explain leaf divergence. On the same branch we observe successively a series of Cycles belonging to orders of a less and less high number, in proportion as the axis of the branch is elongated and all the successive Cycles correspond to the terms of a series of the form:—

$$\frac{p}{q}, \qquad \frac{r}{s}, \qquad \frac{p + n\,r}{q + n\,s}, \qquad \frac{r + (p + n\,r)\,n'}{s + (q + n\,s)\,n'},$$

These fractions are evidently the successive reductions of a continuous fraction of the form:—

$$\cfrac{1}{a + \cfrac{1}{b + \cfrac{1}{n + \cfrac{1}{n' \; - \; - \; - \; -}}}}$$

These series of Cycles, which are found in different plants or on different parts of the same plant, correspond each to one and the same angle of divergence which the eye detects more or less completely, according to the greater or less approximation or condensation of the leaves. We may thus take for the value of this angle either the highest term of each series or the limit towards which this series tends. In the former case we admit a single rational angle, which must be changed for another so soon as we find a higher term of the same series. In the latter case we admit a single irrational angle, which will explain all the phenomena whether present or to come.

Botanists have been apparently alarmed at the term *irrational*. It simply means that any one leaf is not rigorously superposed over another. May there not be some anatomical reason which demands that the leaves, at the time when they are produced close to each other on a vegetative cone, should not be exactly superposed? Admitting the theory of a single angle, we shall see that of all those which exist in nature, the greatest is that of the most common series:—

$$\frac{1}{2} \quad \frac{1}{3} \quad \frac{2}{5} \quad \&c. \ldots\ldots$$

This is the angle in which the surface of the stem will be most nearly equal for both sides of the same leaf. Botanists have observed that in the case in which the laminæ of the leaf are not symmetrical, their greatest development takes place beside the greatest angle. If, as is said, the angle corresponding to the other series is more frequent in fossil plants, may not this frequent occurrence of the larger angle between $\frac{1}{2}$ and $\frac{1}{3}$ indicate a tendency towards a great symmetry of the laminæ?

The fact that the angle comprehended between $\frac{1}{2}$ and $\frac{1}{3}$ is common to almost all Phanerogamous plants, as well as to a great number of Cryptogamous plants, seems to mark a oneness in the origin of all these plants.

Dr. W. Nassau Lees gives a satisfactory report of the cultivation of Cinchonas in the valley of Kangra, Punjab, the most northern locality yet tried. The species introduced are Cinchona succirubra, C. Condaminea, C. micrantha, C. Calisaya, and C. Peruviana, received from the Neilgherry hills.

The cultivation of Cinchonas at Darjeeling is also going on favourably, under the direction of Dr. T. Anderson, Superintendent of the Botanical Gardens, and in charge of Cinchona cultivation in Bengal.

In the 'Appendix to the Journal of the Asiatic Society of Bengal,' No. 123, is a classified list of naturalists and others engaged in the collection of specimens of Natural History, Coins, &c., with notes and queries. The names entered under the departments of Zoology, Botany, Geology, Ethnology, and Coins, are only forty-six, but there are obvious omissions, as T. Anderson and Brandis among Botanists, Jerdon and Walter Elliot among Zoologists. The periodical publication of such a list, indicating the special branches of science which savans scattered over our Indian empire are pursuing, is calculated to be of much service, and we hope that it is a step towards the organization of an annual meeting for the promotion of science generally.

Flowering Plants of the Jardin _of the Mer de Glace of Chamounix, as given by Charles Martins._

[The species marked with an asterisk (*) are found also in Lapland, those in italics occur also on the summit of the Faulhorn.]

The _Jardin_ is about 9,043 feet above the level of the sea; its length is 2,625 feet; its breadth about 985 feet; its distance from the nearest rocks on which some plants grow is at least 2,625 feet. The _Jardin_ is a group of Protogene rocks, projecting between the two affluents which form the _Glacier_ of Talefre.

*_Ranunculus glacialis_, L.; *_R. montanus_, Willd.; R. Villarsii, DC.; _Draba frigida_, Gaud.; _Cardamine bellidifolia_, L.; C. resedifolia, L.; Sisymbrium pinnatifidum, DC.; Silene rupestris var. sub-acaulis, L.; *_S. acaulis_, L.; _Spergula saginoides_, L.; Arenaria rubra, L.; A. serpyllifolia, L.; A. nivalis, Godr.; *_A. biflora_, L.; _Cherleria sedoides_, L.; _Stellaria, cerastoides_, L.; *_Cerastium latifolium_, L.; *C. alpinum, DC.; var. lanatum; *_Spergula saginoides_, L.; Trifolium alpinum, L.; *_Sibbaldia procumbens_, L.; _Geum montanum_, L.; _Potentilla aurea_, L.; _P. glacialis_, Hall; _P. grandiflora_, L.; _Alchemilla pentaphylla_, L.; *_Epilobium alpinum_, L.; _Sedum atratum_, L.; _S. repens_, Schl.; *S. annuum, L.; Sempervivum montanum, L.; S. arachnoideum, L.; *_Saxifraga stellaris_, L.; _S. aspera_, L.; _S. bryoides_, L.; Meum Mutellina, Gærtn.; _Gaya simplex_, Gaud.; Bupleurum stellatum, L.; Cacalia alpina, Jacq.; C. leucophylla, Willd.; _Tussilago alpina_, L.; *_Erigeron uniflorus_, L.; *_E. alpinus_, L.; _Pyrethrum alpinum_, Willd.; *_Omolotheca supina_, Cass.; *Gnaphalium dioicum, L.; *G. alpinum, Willd.; Arnica montana, L.; Senecio incanus, L.; _Cirsium spinosissimum_, Scop.; Leontodon squamosum, Lam.; _L. aureum_, L.; Taraxacum lævigatum, DC.; *Hieracium alpinum, L.; H. angustifolium, Hoppe; H. glanduliferum, Hoppe; H. Halleri, Vill.; _Phyteuma hemisphæricum_, L.; Campanula barbata, L.; Primula viscosa, Vill.; Gentiana purpurea, L.; G. acaulis, L.; G. excisa, Presl; _Linaria alpina_, DC.; *_Veronica alpina_, L.; _V. bellidioides_, L.; _Euphrasia minima_, Jacq.; Plantago alpina, L.; *_Salix herbacea_, L.; _Juncus Jacquini_, L.; *J. trifidus, L.; Luzula lutea, DC.; _L. spadicea_, DC.; *_L. spicata_, DC.; _Carex curvula_, All.; _C. fœtida_, Vill.; _C. sempervirens_, Vill.; C. ferruginea, Scop.; *_Phleum alpinum_, L.; Anthoxanthum odoratum, L.; *_Agrostis rupestris_, All.; _A. alpina_, Scop.; _Avena versicolor_, Vill.; _Poa laxa_, Hæncke; P. laxa var. flavescens, Koch.; *_P. alpina_, L.; _P. alpina_ var. _vivipara_, L.; Festuca Halleri, All.

There are thus 87 flowering plants on the _Jardin._ To these we have to add 16 Mosses, 2 Hepaticæ, and 23 Lichens, making a total of 128 plants which are found growing on this islet of vegetation surrounded by perpetual snow. Of the 87 flowering plants 50 are marked in italics, as being found also on the Faulhorn, an isolated Alpine summit. These florulas may represent well Alpine vegetation at its highest limit. Of the 87 species, 5 form a part of the Spitzbergen Flora, _viz._:—Ranunculus glacialis, Cardamine bellidifolia, Cerastium alpinum, Arenaria biflora and Erigeron uniflorus; while 24 are found in Lapland. The subnival flora of the Alps corresponds to that of

Northern Lapland, as, for instance, about Altenfiörd; while to find a vegetation analogous to that of Spitzbergen we must ascend on the Alps above the limit of perpetual snow.

Botanical Excursion to Eastern Lapland.

M. Fellman, accompanied by MM. Brenner and Laurin, students of the University of Helsingfors, and a pupil of the Botanic Garden of the University, made a trip to Lapland lately, and collected about 300 species of Phanerogamous plants, 20 species of Ferns, and several Lichens. The party proceeded from Sordavala to Petrosavodsk, Kiwatsch, and Suma on the southern coast of the White Sea. Afterwards they went to the islands of Solovetskoi, and to Kem and Keret on the western shore of the White Sea. The Gulf of Kantalaks, and Umba, a Russian village on the southern coast of the peninsula of Lapland, were then visited. In this valley the people live by fishing; no part of the land is cultivated, if we except the western side, where some potatoes are raised. About six leagues east from Umba is the small peninsula of Turii, the western coast of which is granitic and rocky, while the east is flat and sandy as far as Pialitsa, where some clay and a few rocks are met with. The forests of the southern coast of Turii consist of Birch and Spruce. The latter attains here the height of 25 feet, with a circumference of 2 feet. *Pinus sylvestris* does not bear the maritime climate, but retires about two leagues from the sea. The vegetation of this desert region consisted of *Cladonia*, *Stereocaulon*, *Platysma nivale*, and *Empetrum nigrum*: in some humid spots are found *Salix glauca* and *S. phylicifolia*. Such treeless deserts are here called *Tundra*. Baer divides them into *Flechten tundra* (dry tundra), where Lichens predominate, and *Moos tundra* (moist tundra), where Mosses, especially *Sphagnum* and *Polytrichum*, abound. Besides the plants mentioned the following also occur:—*Arctostaphylos alpina*, *Calamagrostis neglecta*, various species of *Festuca*, *Carex ampullacea*, *Eriophorum angustifolium*, *E. vaginatum* and *E. alpinum*, *Betula nana* and *Juniperus communis*.

The travellers proceeded to Ponoi, situated on a river of the same name, the banks of which presented a luxuriant vegetation. Eighteen days were spent in the examination of the Flora of Ponoi. Among the plants collected may be noticed the following:—*Poa cæsia*, *P. sudetica* var. *remota*, *Eriophorum Callithrix*, *Luzula hyperborea*, *Gentiana tenella* and *G. nivalis*, *Pæonia anomala*, *Androsace septentrionalis*, *Pedicularis sudetica*, *Armeria arctica*, *Thalictrum rariflorum*, *Eutrema Edwardsii*, *Draba hirta*, *Arenaria ciliata*, *Cotoneaster vulgaris*, *Aira alpina*, *Juncus glaucus*, *I. castaneus*, *Aster sibiricus*, *Ligularia sibirica*, *Hedysarum obscurum*, *Cineraria campestris*, *Veratrum lobelianum*, *Aconitum Lycoctonum*, *Senecio octoglossus*, *Vicia sylvatica*, *Daphne Mezereum*, *Lychnis alpina*. The common heather, *Calluna vulgaris*, is not seen at Ponoi.

The inhabitants of Ponoi are half Russians, half Laps; they live together in harmony. On the southern side of the Peninsula the population is entirely Russian. During the summer the Laplanders from the interior of Russian Lapland betake themselves to the shores of the White Sea for fishing. From this they derive their chief means of subsistence. They do not drink the milk of the reindeer, nor do they make cheese from it, as is the case in Finland and Swedish Lapland. The inhabitants of the more western parts of East Lapland (who are called Kiwi-Lappalaiset, or stony Laps) do not betake themselves to the sea during summer, but remain beside their lakes and rivers. They are poorer than the others. The Russians inhabiting the southern coast have the reindeer as well as cows and sheep. The Lap is fond of tobacco, while the Russians of the old faith (Staroverts) consider it a sin to use this drug, and never smoke it. Both nations are fond of ardent spirits. In a single village, consisting of sixteen families, 1,000 vædro (about 2,860 gallons) of brandy are annually consumed.

The party did most in the way of collecting plants at Ponoi. Leaving it they journeyed slowly along the northern coast of the peninsula of Lapland and reached Kola. They then proceeded to *Paanajærvi*, on the frontier of Finland, and returned to Helsingfors, after having traversed 700 leagues. From Keret to Kola around the Peninsula of Lapland is 225 leagues. Among the plants collected at Kola and near Swætoi-nos (*promontorium sanctum*) the following may be noticed, *Astragalus oroboides*, *Zannichellia polycarpa*, *Pedicularis verticillata*, *Atriplex patula* var. *hololepis*.

M. Fellman remarked that *Zostera marina* was found all along the western shores of the White Sea. In Eastern Lapland the only Alder which was seen was *Alnus pubescens;* it disappeared to the north of Ponoi, and was again seen near the fjord of Kola. The same was the case with the Spruce, which appears to be *Pinus Abies* var. *medioxina* of Nylander, or *obovata* of Ruprecht. The typical form of *Pinus Abies* occurs between Kantalaks and Kuusamo. Along the coast *Betula tortuosa* grows, and in the interior of the peninsula, near Kola, *Betula alba*. Among species new to Eastern Lapland, the following are enumerated :—*Veronica officinalis*, *V. Chamædrys*, *Littorella lacustris*, *Subularia aquatica*, *Brassica campestris*, *Raphanus Raphanistrum*, *Callitriche autumnalis*, and *Hippuris maritima*.

Among ferns collected we may notice—*Asplenium crenatum*, Fr.; *Botrychium lanceolatum*, Rupr.; *B. matricarioides*, Willd. No *Isoetes* nor *Chara* was found by the party in the peninsula of Lapland. In the lakes of Susijærvi and Ruanjærvi (lat. 67°) they found *Isoetes echinospora*, Dr. They noticed a singular deficiency in species of Lichens. One cause of this may be the absence of forests. Near Ponoi the following Lichens were gathered :—*Siphula ceratites*, Whlnb.; *Thamnolia vermicularis*, Ach.; *Bæomyces placophyllus*, Ach.; *Alectoria ochroleuca* and *A. nigricans*, Ach.; *Nephroma expallidum*, Nyl.; *Peltigera polydactyla*, Hoffm.; *Sticta linita*, Ach.; *Parmelia sulcata*, Tayl.; *P. saxatilis*, *P. physodes*, and *P. prolixa*, Ach.; *Pannaria nigra*, *Squammaria gelida*, *Lecidea arctica*, Sommf.; *L. stenotera*, Nyl.

In speaking of the Russian Laps, called Murmanski, who live by fishing, M. Fellman states they use certain magical arts in order to take the fish and to render them more abundant. An element of great importance in the magical proceedings is an earthy substance called *Rosli-ladan*, which is sold in the churches. A fisher always carries a certain quantity of this substance (however small) with him. The magical ceremony is performed by hollowing out a piece of wood in a cup-like manner, and putting in some bits of charcoal sprinkled over with the *Rosli-ladan*. They then pass the cup over the nets while the operator repeats some magical words in a low tone of voice, spitting energetically from time to time. The ceremony is finished by certain recommendations, after which the magician gives the assurance of plenty of fish. The invocation of the magician is addressed to St. Peter and St. Paul, who are requested to draw fish into the net of the person to whom it belongs.

M. Charles Martins has recently published an account of the Vegetation of Spitzbergen compared with that of the Alps and Pyrenees.*

Spitzbergen, situated between 76° 30′ and 80° 50′ of latitude, may be said to exhibit the extreme limit of our European Flora. It may be said to furnish a representation of the Glacial epoch which has preceded that in which we live. The climate of Spitzbergen is not so cold as that of the northern parts of America situated in the same latitude, such as the extremity of Baffin's Bay known by the name of Smith's Sound. This modification of the climate is due to the action of the Gulf stream.

The following are the mean monthly temperatures of Spitzbergen under latitude 78°:—

January	−18·2 Cent.	July	2·8 Cent.
February	−17·1	August	1·4
March	−15·6	September	− 2·5
April	− 9·9	October	− 8·5
May	− 5·3	November	−14·5
June	− 0·3	December	−15·0

The mean temperature of the year is −8·6 Cent. After entering fully into the details of climate and temperature M. Martins notices the physical and geological structure of the Islands, and then proceeds to consider the Flora. The vegetation is scanty. It occurs on the dark rocks on which the snow has melted. Lichens and Mosses are the first plants which appear. Among the latter may be mentioned Eremodon Wormskioldii, Brid.; Polytrichum alpinum, L.; and Bryum julaceum, Schr. At the foot of the rocks inhabited by sea-birds, whose guano fertilizes as well as warms the ground, we meet with species of Ranunculus, Cochlearia, and Grasses, along with Papaver nudicaule. Nowhere is a shrub or tree to be seen. The last of these, the Birch, the mountain Ash, and the Scotch Fir, are arrested in Norway under the 70th degree of latitude. There are, however, some ligneous plants, *viz.* two species of Willow (*Salix herbacea* and *S. retusa*), and *Empetrum nigrum*. The rest of the vegetation consists of low herbaceous plants. Many of them are so small as to have been passed over by travellers, and thus we find the list of the plants varying. In 1675 Frederick Martens, of Hamburg, describes and figures only 11 land species of plants. Phipps, in 1773, collected 12, which were named and described by Solander. Scoresby gathered 15, which were described in 1820 by Robert Brown. In 1822 Captain Sabine collected 24, which were determined by Hooker, who also made known the 40 species collected by Parry in 1827. Sommerfelt gave the names of 42 species gathered by Keilhau in 1827. In 1838 and 1839 Vahl, a Danish botanist, along with M. Charles Martins, collected at Bell Sound, Magdalena Bay, and Smeerenberg, 57 species. In 1858 Messrs. Torell, Nordenskiold, and Quennerstedt enriched the Flora by 6 species; and the Scientific Swedish Commission, in 1861, added 21. Malmgren, the botanist of the Expedition, made the total number of Spitzbergen flowering plants 93. M. Lindblom enumerated 152 Cryptogamous plants (Mosses and Lichens), thus making the entire Flora of the Islands 245.

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* 'La Végétation du Spitzberg comparée à celle des Alpes et des Pyrénées.' Par Charles Martins, Professeur d'Histoire Naturelle de la Faculté de Médecine de Montpellier, 1865.

The number of flowering plants is very small. Iceland, in lat. 65°, and with a much smaller surface, contains 402. Of the 93 Phanerogams of Spitzbergen 81 occur in Greenland; 58 in the islands which border the straits of Lancaster, Barrow, and Melville, near the 75th degree of N. L., and 53 on the peninsula of Taymir, in Asiatic Siberia. The crown of flowers which surrounds the north pole is not so varied as that of other regions of the globe. In these northern regions we find the same plants or species belonging to the same genera and the same orders. *Gramineæ*, *Cruciferæ*, *Caryophyllaceæ*, and *Saxifragaceæ* predominate, and amongst the genera we find *Draba*, *Saxifraga*, *Ranunculus*, *Carex*, and *Poa*. All the species are perennial. This seems to be a condition of their existence. Spitzbergen combines a Scandinavian and an Arctic Flora.

M. Martins contrasts the Spitzbergen and Lapland Flora with that of the Alps. On the summit of the Faulhorn he finds 8 Spitzbergen species, viz. *Ranunculus glacialis*, *Cardamine bellidifolia*, *Silene acaulis*, *Arenaria biflora*, *Dryas octopetala*, *Erigeron uniflorus*, *Saxifraga oppositifolia*, and *Polygonum viviparum*, and 40 of the Lapland plants. None of these plants belong to the Arctic Flora properly so called, but to the Scandinavian Flora.

Martins next contrasts the Spitzbergen Flora with that of the *Jardin* and of the Grand Mulets on Mont Blanc, with that near the Vincent Chalet on Monte Rosa, the culminating point of the Col Saint Theodule, and the summit of the Pic du Midi.

The paper contains full lists of the plants on these elevated localities, and exhibits in an interesting manner the relation which they bear to the Scandinavian and Arctic Floras.

Flowering Plants of Spitzbergen, as given by M. Charles Martins.

[The species printed in italics are found in Britain. Those marked with an asterisk (*) are exclusively Arctic, and do not exist in Scandinavia.]

Ranunculus glacialis, L.; R. hyperboreus, Rottb.; R. pygmæus, Wbg.; R. nivalis, L.; R. sulphureus, Sol.; *R. arcticus, Richards; Papaver mudicaule, L.; *Cardamine pratensis*, L.; C. bellidifolia, L.; Arabis alpina, L.; *Parrya arctica, R. Br.; Eutrema Edwardsii, R. Br.; *Braya purpurascens, R. Br.; Draba alpina L.; *D. glacialis, Adams; *D. pauciflora? R. Br.; *D. micropetala? Hook.; D. nivalis, Liljebl; *D. arctica, Fl. Dan.; *D. corymbosa, R. Br.; *D. rupestris*, R. Br.; D. hirta, L.; D. Wahlenbergii, Hartm.; Cochlearia fenestrata, R. Br.; *Silene acaulis*, L.; Wahlbergella (Lychnis) apetala, Fr.; W. affinis, Fr.; *Stellaria Edwardsii, R. Br.; *S. humifusa, Rottb.; *Cerastium alpinum*, L.; *Arenaria ciliata*, L.; *A. Rossii, R. Br.; A. biflora, L.; *Honkeneja peploides*, Ehrh.; *Alsine rubella*, Wbg.; *Sagina nivalis*, Fr.; *Dryas octopetala*, L.; *Potentilla pulchella, R. Br.; *P. maculata*, Pourr.; P. nivea, L.; *P. emarginata, Pursh.; Saxifraga hieraciifolia, Waldst. and Kit.; *S. nivalis*, L.; S. foliosa, R. Br.; *S. oppositifolia*, L.; *S. flagellaris, Sternb.; *S. Hirculus*, L.; *S. aizoides*, L.; *S. cernua*, L.; *S. rivularis*, L.; *S. cæspitosa*, L; *Chrysosplenium alternifolium* var. tetrandrum, Th. Fr.; Arnica alpina, Murray; Erigeron uniflorus, L.; Nardosmia (Tussilago) frigida, Cass.; *Taraxacum palustre*, Sm.; *T. phymatocarpum, Vahl.; *Mertensia* (Pulmonaria) *maritima*, L.; *Polemonium pulchellum, Ledeb.; Pedicularis hirsuta, L.; Andromeda tetragona, L.; *Empetrum nigrum*, L.; *Polygonum viviparum*, L.; *Oxyria reniformis*, Hook.; *Salix reticulata*, L.; S. polaris, Wbg.; *Juncus biglumis*, L.; Luzula hyperborea, R. Br.; L. arctica, Blytt; Eriophorum capitatum, Host.; *Carex pulla*, Good; C. misandra, R. Br.; C. glareosa, Wbg.; C. nardina, Fr.; *C. rupestris*, All.; *Alopecurus alpinus*, Sm.; *Aira alpina*, L.; Calamagrostis neglecta, Ehrh.; Trisetum subspicatum, P. Beauv.; *Hierochloe pauciflora, R. Br.; *Dupontia psilosantha, Rupr.; *D. Fischeri, R. Br.; *Poa pratensis*, var. alpigena, Fr.; P. cenisia, All.; P. stricta, Lindeb; *P. abbreviata, R. Br.; P. vahliana, Liebm.; *Glyceria angustata, Mgr.; Catabrosa algida, Fr.; *C. vilfoidea, Anders.; Festuca hirsuta, Fl. Dan.; *F. ovina*, L.; *F. brevifolia, R. Br. Thus of the 93 flowering plants of Spitzbergen, 69 species occur in Scandinavia, and 29 of them also in Britain, while 23 are exclusively Arctic.

*Ferns of Southern India.**

We have received this work now completed in 20 fasciculi, which is very creditable to the author, one of the most ardent and promising botanists in British India, known by his contributions to the 'Madras

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* 'The Ferns of Southern India, being Descriptions and Plates of the Ferns of the Madras Presidency.' By Captain Beddome, Officiating Conservator of Forests. 4to. Madras, 1864.

Journal of Science,' and the 'Linnean Society's Transactions.' There are 271 plates, executed by the same native artist who delineated a large portion of Wight's *Icones plantarum Indiæ Orientalis*, accompanied by a synopsis of the tribes and an analytical table of the genera with their synonyms. This work is an important addition to our literature, and must find a place in the library of every botanist who wishes to study the Flora of South India; the only previous notice of S. Indian Ferns being a memoir, *Filices Nilagiricæ*, by Gustave Kunze, in the 'Linnæa,' July, 1851.

We are glad to learn that Captain Beddome proposes to publish in six additional fasciculi the ferns peculiar to Northern India.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

Several papers of much interest relating to the rarer metallic elements require a passing notice. The first we may mention is that by C. Winkler, on Indium. So far as we know, Winkler is the only chemist (other than the discoverers, MM. Reich and Richter) who has experimented upon indium; and it is satisfactory to find a substantial agreement in the descriptions of the metal and its compounds. It must be noted, however, that the last investigator deduces a lower atomic weight. The discoverers gave the number 37·07; but the determinations of Winkler lead to the number 35·918, a number which he states, however, as only to be accepted provisionally. Indium, our readers will remember, is found in zinc reduced from blende. The method given by Winkler for its separation is exceedingly simple. Zinc is boiled in dilute hydrochloric or sulphuric acid, until nearly all is dissolved. The black residue left will contain all the indium, together with some iron, arsenic, cadmium, and lead. This residue shows well the characteristic line in the spectrum; but to obtain indium perfectly pure a somewhat tedious process is necessary, which will be found described in the paper indicated below.

Troost has lately obtained Zirconium in the crystallized state, by heating the double fluoride of zirconium and potassium with aluminium. After a very strong heat, the temperature of melted iron, crystalline plates of zirconium, lying close together like the leaves of a book, are found upon the surface of the aluminium. Some zirconium, however, alloys itself with the aluminium; and at a lower temperature, that of melted silver, only an alloy of the two is obtained. Troost arranges zirconium in the carbon group, and places it between the metalloid silicium and the metal aluminium.*

Hiortdahl has communicated to the Academy of Sciences† some researches on zirconia, $Zr\ O_2$, made to ascertain its affinity for bases, and to show that it really plays the part of an acid. It was found that zirconia is but a weak acid. It expels carbonic acid from carbonate of soda at a high temperature, and forms the compound Na O, Zr O_2, which is decomposed by water, zirconia being separated. At a higher temperature the compound 2 Na O, Zr O_2 is produced, and when this is treated with water a crystallized hydrate of zirconia separates. It is remarkable that when zircon, a native silicate of zirconia, or a corresponding mixture of silica and zirconia, is heated with carbonate of soda, only the zirconia enters into combination with the alkali.

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* 'Comptes Rendus,' t. lxi. p. 109.

† 'Comptes Rendus,' t. lxi. pp. 175, 213.

Some compounds of Thorium, another rare metal, have been experimented upon by Delafontaine, Chydenius, and others, principally with the view of determining the atomic weight of the metal, which had been left uncertain by Berzelius.* Although not quite in accordance with one another, they agree in assigning a lower equivalent weight than that of Berzelius. This last authority gave 844·9 as the equivalent of thorina; but, according to Delafontaine and Chydenius, the number should be 823 (O = 100). Chydenius considers thorina as the analogue of zirconia and titanic acid, and has assigned to it the formula Th O_2; Hiortdahl, however, states, in one of the papers quoted above, that thorina will, under no circumstances, combine with bases.

The compounds of Niobium have been of late the subject of many researches by Deville, Marignac, and Blomstrand. The last-named author states,† as the results of his experiments, that only two metals constitute the niobium group—niobium and tantalum. Rose's pelopium has already been proved to be niobium, and Von Kobell's dianic acid, Blomstrand states, is niobic acid, pure, or perhaps mixed with a little tantalic acid. With regard to the atomic weight of niobium, which Rose was unable to fix with certainty, the writers named above differ widely. Deville‡ gives the number 47 or 48·3; but Blomstrand, while admitting that his experimental results are not concordant, states his belief that the true equivalent of niobium is 39.§

We read that a Swedish chemist has succeeded in discovering a cheap and easy method of reducing and casting tungsten. From what is known of the properties of this metal, it would hardly seem susceptible of useful application by itself; but, in the form of alloys, as in the case of tungsten-steel, it may be of great value.

An easily fusible alloy may have an interest and use to many of our readers, so we give the composition of the most easily fusible we have met with in our reading. Von Hauer‖ states that an alloy, having the formula Cd_4, Sn_5, Pb_5, Bi_5, is perfectly fluid at 65·5 C. The proportions for making this compound can be easily calculated from the equivalent weights of the metals.

Not many of our readers, probably, have seen *pure* iron, and they may perhaps be astonished to learn, upon the authority of Stahlschmidt,¶ that the metal which the author obtained by reducing the nitride in a stream of hydrogen is of a silver-white colour, and so soft that it may be cut with an ordinary knife.

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* 'Bulletin de la Société Chimique de Paris,' April, 1865, p. 278.

† 'Comptes Rendus,' t. lxi. p. 337.

‡ 'Comptes Rendus,' June 12, 1865.

§ 'Annalen der Chem. und Pharm.,' Bd. lix. s. 198.

‖ 'Journal für prakt. Chem.,' Bd. 96, s. 436.

¶ 'Poggendorff's Annalen der Chem. und Physik,' No. 5, 1865.

Before leaving the metals, we may mention a process for the preparation of potassium, which the author, Beketoff,* thinks may be applied to the commercial manufacture of the metal. He simply heats hydrate of potassium and aluminium in a gun barrel. The process is certainly extremely simple; but while aluminium is only to be obtained with the aid of sodium, it is not likely to be employed by a manufacturer.

Though scarcely belonging to Chemistry, we may place on record here Mr. Gale's process for rendering gunpowder non-explosive for storage and transport. The inventor simply mixes three or four parts of finely-powdered glass with one part of the powder, and when the latter is required for use the two are separated by means of a sieve.

Some very useful papers on analytical chemistry have been published since our last. The first we may notice has reference to the analysis of waters,† and gives a method of arriving at the true composition of the saline matters. The author first treats the dry residue several times with boiling absolute alcohol, by which he separates the chlorides. The residue is boiled in water, and this solution gives the soluble sulphates. The residue, insoluble in water, may still contain sulphate of lime, the amount of which may be calculated from the sulphuric acid, while the excess of lime, magnesia, and iron found in a hydrochloric solution, may be calculated as carbonates.

A residue insoluble in water and acids is sometimes also very difficult of fusion, and chemists will thank Professor Bloxam for a simple method‡ of fluxing small quantities, which will save analysts much trouble. The author prepares a mixture of one part of fine charcoal and six parts of nitre. Five grains of the insoluble residue to be examined, and ten grains of carbonate of soda, are mixed with seventy grains of the deflagrating mixture, and a match is applied. Deflagration and consequent fusion immediately take place. The operation may be performed in a thin porcelain dish, or even on an iron tray, for the metal will not be affected. It is sufficient to say that the process answers with such refractory substances as quartz sand, pipe-clay, and fluor spar. Chrome iron ore alone withstands the treatment.

In estimating alkalies it is necessary to convert nitrates into chlorides. This is done by evaporating the nitrate with an excess of hydrochloric acid. Dr. Leucanus§ finds that it requires the repetition of the evaporation with acid several times to convert the greater part of the nitrate into chloride. A small proportion of nitrate, indeed, remains undecomposed after twelve evaporations. The author therefore suggests igniting the nitrate with grape sugar to convert it into carbonate, and extracting the alkali from the carbonaceous residue with hydrochloric acid.

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* 'Zeitschrift für Chem. und Pharm.' New Series. Bd. 1, s. 376.

† 'Chemical News,' vol. xii. p. 87.

‡ 'Journal of the Chemical Society,' August, 1865.

§ 'Zeitschrift für Analyt. Chem.,' Bd. iii. s. 403.

Fresenius has made a series of experiments on the determination of phosphoric acid as phosphomolybdate of ammonia.* He finds, in effect, that the results are sufficiently correct in a nitric acid solution; but hydrochloric acid, even when very dilute, somewhat interferes with the precipitation.

We may here notice very shortly a method of elementary organic analysis, proposed by Dr. Ladenburg,† to supersede in some cases Liebig's combustion process. The author encloses a weighed amount of the substance to be analyzed in a small glass bulb, which he places in a stout tube containing a weighed quantity of iodate of silver and some monohydrated sulphuric acid. This tube being sealed, the bulb is broken by agitation and the tube heated, whereupon the organic substance is oxidized at the expense of the oxygen of the iodic acid. At the end of the operation the tube is weighed; it is then opened, and the carbonic acid pumped out; the loss of weight gives the amount of the acid formed. The free iodine is then estimated in the sulphuric acid solution by Bunsen's method; and thus the amount of oxygen required for the oxidation is ascertained. This method, it will be seen, is specially applicable for the volatile hydro-carbons.

Mr. Ullgren has contributed to the 'Journal of the Chemical Society'‡ a method of estimating very closely the amount of blue colouring matter in indigo. It is a volumetric method based on the fact that ferricyanide of potassium in the presence of a free alkali, destroys the indigotin and produces colourless isatin. The solution of ferricyanide he employs contains 2·5115 grammes of the salt in a litre, consequently 2 c.c. change 1 milligramme of indigotin into isatin. To ensure accuracy in the determination, the quantity of sulphuric acid added to the indigo solution should not be too great, and the temperature should not exceed 50°; the indigo solution must be very dilute; and the solution must be made strongly alkaline by carbonate of soda. The operation may be regarded as complete when the bluish-green solution assumes a grey-yellow appearance; or when every tint of blue has disappeared.

As a ready means of distinguishing between bismuth and lead, we may give a test described by Nicklés, who shows that the chlorothallate of ammonia precipitates bismuth, but does not precipitate lead.

In connection with organic chemistry, we notice the researches of M. Fremy on the green colouring matter of leaves.§ The author shows that chlorophyll yields two distinct colouring matters which may not, however, primarily exist in that body. When an alcoholic solution of chlorophyll is boiled with hydrate of baryta, a yellow body, phylloxanthine, is precipitated along with a barytic salt of phyllocyanic acid. The former may be dissolved out by alcohol, and obtained in reddish-yellow crystals by evaporating the solution. The barytic salt mentioned when decomposed by sulphuric acid, gives a solution of phyllocyanic acid which is green, or reddish-violet, or blue according to the strength of the solution. M. Fremy thinks it possible that chlorophyll may be a sort of soap, in which phylloxanthine plays the part of glycerine, and phyllocyanic the part of the fatty acid.

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* 'Zeitschrift für Analyt. Chem.,' Bd. iii., p. 446.

† 'Annalen der Chem. und Pharm.,' Bd. lix. s. 1.

‡ August, 1865.

§ Comptes Rendus, t. lxi. p. 188.

The oxidation of fatty matters has for a long time engaged the attention of M. Cloëz, who has recently published the results of his investigations.* The author shows that it is not a simple oxidation attended with the production of carbonic acid, when an oil is exposed to atmospheric air. Other compounds with hydrogen he states are formed, among which he has recognized acrylic and acetic acids. Other volatile compounds he thinks are also formed. Oils exposed in coloured glasses he finds, after a time, to oxidize faster than those exposed to white light: heat likewise greatly accelerates the oxidation.

Very little in the technical applications of chemistry calls for notice this quarter. M. Pasteur has tried the effect of artificially applied heat in ripening wines, and preventing what is called sickness in them. He shows that a short exposure to 60° or 70° is sufficient to destroy the parasitic germs, which he believes to be the cause of the sickening, while the increased temperature accelerates oxidation, and produces the compounds which give the flavour of age to the wine.

A. M. Pienowski has suggested the employment of acetate of soda in place of common salt for preserving meat. He states that the former salt is more easily removed from the meat, while the flavour communicated is preferable.

We may give here two processes proposed for obtaining oxygen at a cheap rate. M. Carlevaris suggests heating binoxide of manganese with fine sand, thus producing silicate of manganese and setting free one equivalent of oxygen. M. Archereau proposes to heat silica with sulphate of lime and so produce silicate of lime and set free a mixture of sulphurous acid and oxygen. The former gas he removes by passing the mixture through water.

PROCEEDINGS OF THE CHEMICAL SOCIETY.

But one meeting of the Chemical Society has been held since our last report. At this meeting Dr. Frankland gave a verbal account of experiments by himself and Mr. Duppa on the transformation of the lactic into the acrylic series of acids; and Mr. W. H. Perkin read a paper on the action of nascent hydrogen on Azodinaphthyldiamine. The titles of some other communications were read, which we find at length in the Journal of the Society, and may here refer to. Professor Church described a new Cornish mineral of the Atacamite group, and also a specimen of limonite from Cornwall. The description of these will be more properly included in our mineralogical report.

Mr. R. Warington, junior, made a communication on the occurrence of manganese in oolite and lias, and showed the presence of the metal in the leaves and trunks of trees growing on the soil. It is pointed out that the amount of manganese in the lias is considerably above that in the oolite.

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* 'Comptes Rendus,' t. lxi. pp. 236, 321.

Professor Church also publishes some analyses of bronzes found in Great Britain, which show that much of the so-called bronze of the Roman period should be called brass, being composed principally of copper and zinc. A specimen of Celtic bronze, analyzed by Mr. Church, was mainly composed of copper, tin, and lead, while another was principally copper and zinc.

V. ENTOMOLOGY.

(Including the Proceedings of the Entomological Society.)

In June, 1861, Professor N. Wagner, of Kasan, accidently found what he calls "the spontaneously multiplying larvæ of," to him, an "unknown member of the Diptera."* These larvæ were filled with other larvæ exactly like them. At first he thought it was a case of parasitism, but after examining many of them, he became convinced that the secondary larvæ had been developed from "embryonal bodies" indisputably belonging to the organism of the parent larvæ. This discovery does not appear to have excited much attention; an American author, however, considers the statement to be "a pure and simple delusion." In a recent number of Siebold and Kölliker's Zeitschrift für Zoologie (1865, p. 106) Professor Wagner enters into a long and elaborate account of his observations. He says that "in carefully watching the larvæ every day one sees clearly that new larvæ crawl out of them, and, like them, in from seven to ten days bring forth other new larvæ." Some of these he kept by him during the winter, and the larvæ multiplied in this way all the time. The pupa state was assumed from the 6th to the 8th of June, and three or four days after the insects came forth. The "embryonal bodies" differ from eggs, in that they arise from alterations in the organism, while eggs are developed in special sexual organs. In the first case, impregnation is never necessary, and to this category of organic generations Professor Wagner would confine the term "Parthenogenesis." More recently Professor von Siebold, having had some of the larvæ sent to him, is satisfied that the young larvæ are really produced by the mother larvæ, and therefore "that all thoughts of their being parasites must be given up."

The conclusions of Mr. Walsh respecting dimorphism in the Gall-flies† appear to have met with less acceptance in Germany than in this country. M. Reinhard, of Bautzen,‡ considers that

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* It is the *Miastor metraloas* of Meinert, and belongs to the sub-family Cecidomyinæ. A well-known species in this group is the wheat-fly (*Cecidomyia tritici*).

† 'Proc. Entom. Soc. of Philadelphia,' March, 1864.

‡ 'Berliner Entom. Zeitschrift,' 1855, p. 1 et seq.

Walsh's hypothesis rests entirely on the identity of the galls,* and that the characters he gives of *Cynips spongifica* produced from the summer gall, and of *Cynips aciculata* from the winter gall, require, from morphological considerations, that they should be generically separated. The transition forms which Mr. Walsh finds between the two galls signify nothing. Galls of various species of cynips often appear to be transitional between other forms, and are only known with certainty when the insect appears. Thus Reinhard says that the galls of *C. lignicola* are scarcely to be distinguished from those of *C. conglomerata*, or the latter from those of *C. Kollari*, although all three galls when fully and normally formed appear very different. So with the galls formed on oak-leaves by our European species, as those of *C. folii*, *C. scutellaris*, *C. longiventris*, *C. agama*, *C. divisa*, and *C. disticha*, which resemble each other so much, that it is not to be wondered at if some examples appear to form a transition from one species to another. In further confirmation of the deceptive resemblances between galls of widely different species, compare those of *Lasioptera rubi* with those of *Diastrophus rubi*, or of *Cecidomyia circinans*† with those of *Neuroterus lanuginosus.* Mr. Walsh appears to have erred in the belief that it is only males which are hatched from unfertilized eggs, for, according to Dr. von Siebold, in the *Psychidæ*, the unfertilized eggs give only females.

Still the facts brought forward by Walsh to bear on his hypothesis are so remarkable, that it is necessary to seek other explanations. Reinhard suggests that *C. spongifica* may either be an inquiline of *C. aciculata*, or that *C. spongifica* and *C. aciculata* may be generically distinct species, only making similar galls. If *C. spongifica* be an inquiline, then it will form an exception to the rule that inquilines always appear either at the same time or *after* the gall-maker; further, *C. spongifica* had an inquiline of its own (*Synophrus læviventris*, Ost. Sack.), while with *C. aciculata* nothing else appeared.

So far as negative evidence *can* go, the male sex of many genera of Cynipidæ has no existence, so that reproduction is exclusively confined to the females. Unwilling to adopt this conclusion, it has been attempted to show that the males may be among the inquilines. Reinhard, however, objects to this: he thinks that if there were really dimorphism in the females, so that both the inquiline female and the maker of the gall were served by the male inquiline of the former, that only the same species of inquiline would be found in the same gall. This is by no means the case, as Hartig has bred from Cynips folii, *Synergus nigripes*, *S. flavicornis*, &c., and from Biorhiza renum, *Synergus tibialis*, *S. luteus*, &c. Furthermore, inquilines ought only to occur in the agamic genera, whereas, on the contrary, they are found in the galls of such bisexual groups as *Andricus*, *Teras*, and others. All the genera appearing in summer are two-sexed, the flies taking a short time to develope, as they come out in the same summer in which the gall first appears. The agamic series appears in the winter, that is, from October to December. A third series, including the genera *Aulax*, *Diastrophus*, and *Rhodites*, is delayed to the second summer; of these the males are much rarer than the females.

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* Mr. Wilson Armistead, of Virginia House, Leeds, who "has been an observer of galls and similar excrescences for twenty years or more," is "preparing a volume to contain the result of these observations." He makes an earnest appeal to all naturalists for information and any particulars respecting them.

† *Lasioptera* and *Cecidomyia* belong to the Diptera.

Dr. A. Laboulbène * has given a long account of the musical organs of a moth (*Chelonia pudica*). These were discovered more than thirty years ago by M. Villars, but the subject has not excited much attention. They exist in both sexes, but are larger in the males, and consist of a hollow triangular cavity, covered by a thin dry membrane, placed on each side of the thorax, close to the insertion of the inferior wings. The sounds, which the writer compares to that of a stocking-maker's machine, are, he considers, caused by little taps given by the legs on the membrane, or by rapid lateral motion of the knees. Many species of the genus *Setina* are also furnished with similar organs, but their size varies in the females, some having them nearly as large as in the males, while in others they are scarcely distinguishable. There are somewhat analogous organs found in other members of the family Lithosiidæ, to which these two genera belong, but they are generally covered with scales, and are not calculated to produce sounds. In one species—*Pericopis Isse*—they attain to the highest degree of development, while in a very nearly allied form they do not exist.

A new position for a sound-producing apparatus has just been brought under the notice of the Entomological Society by Mr. Pascoe. The insect in which it occurs is a species of the lamellicorn genus *Bolboceras*, from Australia. The upper portion of its posterior coxa has certain grooved lines which correspond to another series of grooved lines in the cotyloid cavity, and the friction of one against the other causes a grating sound, just as a similar structure of the portion of the mesothorax lying under the prothorax produces the sounds so well known in many longicorn beetles, and which has earned for the Prionus coriarius in some parts of Germany the name of the "fiddler."

At a meeting of the Entomological Society in the spring, the Rev. Hamlet Clark, citing a passage from 'Cameron's Travels' in Malayan India, in which a statement was made that fire-flies (*Lampyridæ*) appeared to have a habit of exhibiting and extinguishing their light contemporaneously, remarked that he had observed a similar habit in the fire-flies of Brazil. This assertion appears to have occasioned some surprise: Mr. Bates, who had himself found some eighty or ninety species in the Amazons region, thought, on the contrary, that there was no concert between the different individuals, and that the contemporaneous flashing was an illusion produced probably by the swarms of the insects flying amongst foliage, and being continually, but only momentarily, hidden behind the leaves. Mr. W. Wilson Saunders in India, and M. Sallé in Mexico, had also never remarked any intermittency in the light. At the July meeting, however, Mr. Clark read an extract of a letter from Mr. Fry, a gentleman who had resided many years in Brazil, and who is well known to many members of the Society as one of our foremost entomologists, corroborating the accuracy of his statement. Mr. Fry writes, "I can confirm your observations that the fire-flies of the genus *Aspisoma* flit at night in great numbers over low-lying damp fields, chiefly near water, emitting light at short intervals of three or four seconds, the majority keeping time with each other, as if in obedience to the baton of a leader. I think it is only the fire-flies of that genus who practise it. The numerous fire-flies common in Mexico and North America belong chiefly to the genera *Ellychnia* and *Photuris*, whose habits are different, so far as I have had an opportunity to observe their congeners in Brazil." 'The Reader' (April 1, 1865) observes, "Here is a new insect-wonder, before which the economy of bees and ants will sink into insignificance." Another moot-point, which has lately occasioned the revival of an old controversy, respects the luminosity of the lantern-fly * (*Fulgora laternaria*). The general opinion of the leading entomologists, including those who have seen them in their native haunts, is that they are not luminous; but a letter was read from an inhabitant of Belize, in which it was stated that the writer had kept one "a day" and that it was "decidedly luminous." It is not by off-hand statements that such problems are to be decided, though there seems to be no impossible reason why what has been asserted by so many should not be to a certain extent true.

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* 'Ann. Soc. Entom. de France,' t. iv. p. 689 et seq., 4^{me} sér.

Athough Bibliography scarcely enters into these Reports, it would be an omission not to mention such a work as has been just published by the Ray Society. It is on the 'British Hemiptera-Heteroptera,' by Messrs. Douglas and Scott, and forms a thick handsome octavo volume, with twenty-one exquisite plates by Mr. Robinson. Many of the non-entomological members of that Society will be astonished to find what numbers of strange and beautifully-coloured forms are living around them, belonging to a group of which the only member they know is the disgusting bed-bug. So far as we can judge—for the work has only been in our possession a few hours—the authors have executed their task most carefully and conscientiously, but it is to be regretted that they had not adopted a less ramified and complicated system than that of Dr. Fieber. Besides the divisions, sub-divisions, and sections, some of them with very uncouth and not very classical names, we find that the land-species alone described in this volume are distributed into not less than fifty-four families.

ENTOMOLOGICAL SOCIETY.

At the June meeting of this Society, letters were read from Mr. Edwin Reed, who has recently gone to Bahia with the intention of collecting in that, entomologically, little known locality, and from Mr.

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* The lantern-flies do not belong to the Phasmidæ, as a writer in the 'Natural History Review' (1865, p. 19) has stated, but to the Fulgoridæ. The two families do not even belong to the same order. Is this the writer who thinks that "*ex-professo* entomologists should blush" (*id.*, p. 198) because Mr. Lubbock accidently found an aquatic Hymenopteron in a basin of pond-water?

Brewer, who had proceeded to the Azores with the same object. To all who take an interest in the geographical distribution of animals, the result of an investigation of the insect fauna of those islands will be looked forward to with great interest. Among the insects exhibited was a specimen of *Apate capucina*, Linn., a handsome boring beetle, captured in Bishop's Wood by Mr. Edgar Smith, which, although once taken by Sir Thomas Pasley, but under rather suspicious circumstances, in Pembroke dockyard, and by the Rev. F. W. Hope, has not been admitted into the British list. Mr. F. Moore read a paper on the genus *Saturnia*, with descriptions of new species.

July.—The Rev. Hamlet Clark read a letter from Mr. Fry respecting the simultaneous flashing of the light of the fire-flies (*Lampyridæ*). A letter was also read from the Rev. Douglas Timmins, giving an account of the winter entomology of Cannes (Dep. Var.). Dr. Armitage exhibited the cocoon of a female *Œceticus* from Monte Video, to which three males had resorted at the same time, and had been killed while their abdomens were still in the cocoon. Mr. Bates read a letter from Mr. Walsh, of Illinois, giving an account of the habits, and particularly of the hybernation, of the American species of *Limenitis*.

August.—Mr. W. Wilson Saunders brought for exhibition a large grasshopper (*Steirodon?*), which, with others in a young state, had been imported in a case of orchids, and having made their escape had done great injury in one of Mr. Saunders's hothouses. What was remarkable, they fed only during the night, and when not feeding appeared to be constantly engaged in cleaning their legs and antennæ, by drawing them through the mouth. Although Mr. Bates remarked that he had not met with any of nocturnal habits in South America, it is known that our *Acrida viridissima* is frequently found feeding at night. A *Cryptocephalus* (*C. decem-punctatus*), recently taken at Rannoch, and new to the British list, was exhibited by Mr. Sharpe. A collection of insects of all orders, made by Mr. Bouchard, at Santa Martha, was also laid before the meeting. Lieutenant Beavan sent from India some very beautiful drawings of the Tusseh silk-worm. A letter was read from Mr. S. Stone respecting the extraordinary abundance of female wasps last April, notwithstanding it appeared from the observations of many members that none were now to be found. No adequate explanation was given. A paper was read from Mr. C. A. Wilson, of Adelaide, on the Buprestidæ of South Australia. Mr. Baly also read a paper on the Phytophaga.

VI. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Geology is now so comprehensive a science, the number of labourers in its many fields has become so great, their discoveries are so numerous, and the advance of the science is so rapid, that in the few pages devoted to this Chronicle we can only pretend to give outlines of some of the most important subjects occupying the attention of geologists, together with notices of a few of the best investigations into the structure of our own islands. Frequently we are obliged to omit all mention of valuable results arrived at, both at home and abroad; and our endeavour has generally been to give as complete notices as possible of a few of the most instructive and successful researches that have recently been carried out, rather than short accounts of everything that has been published during each quarter, as in the latter case our Chronicles would have been little better than booksellers' catalogues. We have also endeavoured to select our subjects so as to show that important advances are continually being made in our knowledge of the structure of the earth, and of the forces which have modified its surface in past times; and it is with this view that we have sometimes given great prominence to apparently "out of the way" researches.

Within the last two or three years much attention has been given to the Physical Geography and Geology of the Sahara; and attempts have several times been made to explain important phenomena by means of the ancient condition of that vast and sterile area. The last two numbers of this Journal have contained communications relating to one supposed effect of the Sahara on the Meteorology of the globe, and our readers will therefore feel some little interest in the other phenomena which have been thought to have more or less connection with either its past or present condition.

The present characters of the Sahara are too well known to need description at our hands; but, considering them geologically, the question inevitably arises, When did the Sahara first assume these features? It appears that the great geographer Ritter, nearly half a century ago, suggested "that the African desert had been under water at a very modern period;"* and in 1852, M. Escher von der Linth gave it as his opinion, "that if this submergence were true, it would explain why the Alpine glaciers had attained in the Post-pliocene period those colossal dimensions which Venetz and Charpentier, reasoning on geological data, first assigned to them."† The subsequent discovery of the common existing cockle and other marine shells in the heart of the desert, and at various depths beneath the surface, left no doubt as to the submergence; and, granting this, M. Escher's conclusion seems reasonable enough, for everybody knows how the sirocco (called Föhn in Switzerland) sometimes nearly strips the Alps of their snowy covering. Sir Charles Lyell has also remarked, that during the submergence of the Sahara the sirocco would not only be deprived of its heat, but would also become charged with moisture, which being deposited on the mountains in the form of snow, would *add* to the volume of their glaciers; that is to say, the glaciers would be larger, positively by the sirocco bringing material that it does not bring now, and negatively by its not melting the snow and ice, which it does now to a considerable extent. It therefore appears that the Sahara is very intimately connected with the present moderate climate of Europe.

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* Lyell's 'Elements,' sixth edition, p. 175.

† Op. et loc. cit.

Another phenomenon is the one which has been discussed in this Journal, namely, What influence has the Sahara on the north-east trade-wind? The cause of this wind has generally been stated to be a rush of cold air from the north, the direction of which is modified by the rotation of the earth on its axis. The existence of a south-east trade-wind on the other side of the equator is a strong argument in favour of this explanation, and against the view that the sister wind is due to a local cause; but that the Sahara may modify the force and direction of the north-east trade does not appear improbable.

The Sahara was submerged, then, during the Glacial Period; but what was its condition previously? This is the question that has chiefly induced us to notice the phenomena connected with the great African desert in this Chronicle, as the answer to it is of great importance to those who take an interest in Tertiary geology, and has only just been published.

The artesian wells sunk by the French have proved the existence of underground sheets of water at depths ranging to as much as 500 feet, and it is in boring them that so many facts bearing on the History of the Sahara have been discovered. M. Ville has written several memoirs descriptive of different portions of the desert, and his last production, entitled "Notes d'un Voyage d'Exploration dans les Bassins du Hodna et du Sahara," and published simultaneously in the last number of the 'Annales des Mines,'* and in the 'Bulletin de la Société Géologique de France,'† is remarkably important and contains a host of most interesting facts bearing on the distribution of these underground sheets of water. The point to which we now wish to draw attention is this: M. Ville shows that the surface in one part of the desert is formed of a Quaternary formation (Post-pliocene), to which he gives the name "Terrain Saharien," and nearer the mountains of an *underlying series of deposits of Pliocene age*, containing in some places marine fossils, namely, *Leda subnicobarica*, *Pinna cristellaria*, *Cassis*, *Tornatella*, &c. So far as we know, this fact is quite new, at least to geologists in England, and we await with much curiosity and impatience the publication of complete lists of the fossils, for it is more than probable that the Miocene fauna of the south of Europe, Madeira, &c., may have journeyed eastwards through the ancient desert-sea, and if this has been the case we may expect to find some traces of their passage in these Pliocene deposits of the Sahara. That the beds in question are really Pliocene appears certain, as their age is given on the authority of M. Deshayes.

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* 6^{me} série, vol. vii., 2^{me} livr., pp. 117–156.

† 2^{me} série, vol. xxii.

Dr. Waagen has just published a short but very able brochure entitled, 'Versuch einer allgemeinen Classification der Schichten des oberen Jura,' which reveals a very curious state of confusion in the minds of geologists and palæontologists as to the meaning and correlation of the "Coral Rag" of England and the "Corallien" of the Continent. The author took advantage of a visit to England to make a detailed examination of the Upper Oolitic strata of our south coast, in the neighbourhood of Weymouth; and a comparison of their fossils with those of their continental equivalents has resulted in his conviction of there being a strange delusion respecting the "Corallien" prevailing amongst geologists.

Our classification of these beds is, in descending order:—(1) Purbeck beds, (2) Portland rock, (3) Portland sand, (4) Kimmeridge Clay, (5) Upper Calcareous Grit, (6) Coral Rag or Oxford Oolite, (7) Lower Calcareous Grit, (8) Oxford Clay, (9) Kelloway rock. Dr. Waagen omits the Purbeck beds, and discusses the six succeeding subdivisions, comparing them with their continental equivalents, according to the following classification:—

	English Formations.	*Continental Equivalents.*
Kimmeridge Group.	1. Portland Stone. 2. Portland Sand.	Zone of *Trigonia gibbosa*.
	3. Kimmeridge Clay.	Solenhofen Platten-Kalk, or zone of *Orbicula latissima* and *Acanthoteuthis speciosa*. Zone of *Pterocera Oceani* and *Ammonites mutabilis*. Astarte-limestone and Zone of *Ammonites tenuilobatus*.
Oxford Group.	4. Upper Calcareous Grit. 5. Oxford Oolite	Zone of *Cidaris florigemma* and *Ammonites bimammatus*.
	6. Lower Calcareous Grit.	Zone of *Ammonites transversarius* and *A. Martelli*.

Now the remarkable point is that, according to Dr. Waagen, the "Corallien" of Cirin is on the horizon of the Portland beds, that of Franconia corresponds with the upper division of the Kimmeridge Clay, that of Nattheim (Swabia) with the middle, and that of La Rochelle with the lower; our own Coral Rag and the "Corallien" of the Swiss geologists belong to the next group, and the "Corallien" of Thurmann and Etallon is the equivalent of the Lower Calcareous Grit. Our author characterizes this state of affairs as a "schöne Verwirrung," an expression which we may take to signify a "magnificent muddle!"

Professor M'Coy has contributed a very interesting paper to the August number of the 'Annals and Magazine of Natural History,' entitled "On the Occurrence of *Limopsis Belcheri*, *Corbula sulcata*, and some other recent Shells in the fossil state in Miocene Tertiary Beds, near Melbourne." The first-named species lives at the present day off the Cape of Good Hope, and the few known specimens of it were brought up alive from a prodigious depth by Admiral Belcher. A second species of *Limopsis* (*L. aurita*), which has been dredged by

Mr. Gwyn Jeffreys, off Unst, in Shetland, from a depth of 85 fathoms, and occurs fossil in our Coralline Crag and in the Miocene beds of Germany, is also common in the Australian deposits. The *Corbula sulcata* now lives on the west coast of Africa; with it and the foregoing species occur the recent *Pectunculus laticostatus* of New Zealand, and the Eocene *Dentalium Mississippiense* of Vicksburg. If the remaining species have similar extraordinary ranges, it will be rather difficult to determine how they became associated in the Miocene Australian sea.

Of recent local memoirs, we have a large number before us, all deserving of notice; but we must content ourselves with glancing at the following:—Mr. Boult's paper "On the alleged Submarine Forests on the Shores of Liverpool Bay and the River Mersey," reprinted from the Journal of the Polytechnic Society, is an attempt to show that the three beds of peat occurring at Dove Point, &c., are not the remains of so many submerged forests, but are the results of the bursting of peat-mosses, similar to that of Chat Moss, described by Leland as having occurred in the beginning of the sixteenth century. The author considers also that these forest-beds and the intercalated silts are not sufficient evidence of a depression and subsequent re-elevation of the country. His arguments are ingenious, but rather dogmatically expressed; they do not carry conviction to our mind, and we cannot think that his view is the right one; but his paper is well worth reading, as it forces one's train of thought off the rails on which it usually runs, and happily the inevitable collision with the author's ideas does us no bodily harm.

Mr. Hull's paper on the Drift-deposits, &c., in the neighbourhood of Manchester, has some connection with the one just noticed, as it contains a sketch of some very recent gravel and sand beds at Heaton Mersey, containing an interstratified bed of peat which may represent an old land-surface, but may be due to a former extension of the river. The chief object of the paper is, however, to extend, and in some measure to correct, Mr. Binney's previous observations and classification of the drift-beds of this district. The two classifications are as follow:—

	BINNEY.	HULL.
Recent. . .	1. Valley-gravel and River-terraces.	1. Valley-gravel and River-terraces.
Post-pliocene or Drift .		2. Upper Boulder-clay.
	2. Forest sand and gravel.	3. Middle Sand and gravel.
	3. Till or Boulder-clay.	4. Lower Boulder-clay or Till.
	4. Sand and Gravel, more inconstant and less important than No. 2.	

The last of these papers that we have room to notice is Professor Buckman's Essay "On the Geology of Gloucestershire in reference to Agriculture and Rural Economy," reprinted from the Bath and West of England Agricultural Journal. To the farmers of Gloucestershire it must be a welcome little guide, and we should be glad to hear that its author had expanded it into a more exhaustive text-book. Professor

Buckman treats of the subsoils in relation to water-supply, their adaptation to particular crops, the flora of the district, and other subjects; he also gives analyses of different rocks, and tables showing their relative yield of several crops and their comparative value per acre. A complete series of such memoirs would form a valuable 'Manual of the Agricultural Geology of Great Britain.'

'The Geological Magazine' has lately been remarkably good, and the Original Articles have been more generally interesting than before; three of the most recent papers are brief geological guides to the districts of which they treat, and have doubtless been useful to geological tourists during the past summer: these are, Mr. Mackintosh's "Notes on the Surface-geology of the Lake-district," Mr. Peach's paper "On Traces of Glacial Drift in the Shetlands," and Mr. Davies's account of "A Walk over the Ashbeds and Bala Limestone near Oswestry." Professor Owen's paper on *Miolophus*, a new genus of Mammal allied to *Hyracotherium*, from the London clay of Sheppey, has, of course, a more lasting value. Professor Phillips's note on Oxford fossils is interesting, and Mr. Guppy's paper on the Tertiary deposits of Trinidad is unusually so, as the author infers that a much colder climate prevailed in that region during or near the time of our Glacial Period.

With great sorrow we are again obliged to record the death of an eminent palæontologist. Dr. S. P. Woodward, author of the well-known 'Manual of Recent and Fossil Shells,' and of many original memoirs on conchological and geological subjects, expired at Herne Bay on July 11, at the early age of 43. We must refer our readers to the August number of the 'Geological Magazine' for an obituary notice of this talented naturalist, from whose loss palæontology in England must long suffer.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

The August number of the 'Quarterly Journal' includes a much larger share of the Society's Proceedings than its predecessor. Of the eleven papers contained in it, four treat of the Post-tertiary deposits of Scotland, namely:—

Mr. T. F. Jamieson "On the History of the last Geological Changes in Scotland."

Dr. J. Bryce "On the Order of Succession in the Drift-beds of the Island of Arran."

Dr. J. Bryce "On the Occurrence of Beds in the West of Scotland beneath the Boulder-clay."

Rev. H. W. Crosskey "On the *Tellina calcarea* Bed at Chappel Hall, near Airdrie."

Mr. Jamieson's paper is remarkable as a compilation, and inherently valuable from its containing a large number of new facts, and a classification of them and of those previously known. The author distinguishes in the Post-tertiary beds of Scotland the representatives of no less than six different periods, one of which is Pre-glacial, three are Glacial, and two Post-glacial.

Of the Pre-glacial period there are traces only. The first of the Glacial periods is that of "Land-ice," during which the rocky surface of the country was scratched and polished, and the Boulder-earth was accumulated; the second is the "Period of Depression," during which the Glacial-marine beds, containing Arctic shells, and the stratified beds occurring at high levels were deposited; the third is that occupied by the "Emergence of the Land," during which the glaciers finally retreated, and the Valley-gravels, Moraines, and Submarine Forest-beds were deposited. The close of this period is properly Post-glacial, and Mr. Jamieson considers the submarine forest-beds to fall into this latter category.

The first of the true Post glacial periods is termed by the author the "Second Period of Depression," and within its limits the Estuarine beds and raised beaches of Scotland were deposited; the former are of very great extent, and constitute the well-known Carselands of the Forth and Tay (including the Carse of Gowrie—the Garden of Scotland); in them, also, the first traces of man in Scotland have been discovered. The second and last period is that during which the land was elevated to its present position, and the blown sand, beds of peat, and shell-mounds were accumulated.

Concerning the date of this last change, Mr. Jamieson has nothing new to say, which is a very great pity, as the question is now in anything but a satisfactory condition; he states, however, that artificially chipped flints occur on the surface of some of the mounds, the bases of which are not more than four feet above the sea-level, and strewed on the rolled pebbles of the beaches of the last period, and it seems to us that this evidence is rather against Mr. Geikie's inference that the last elevation of Scotland was posterior to the Roman invasion; but Mr. Jamieson is inclined to be of a different opinion.

In an Appendix the author gives classified lists of the shells found in the different localites and deposits, with their present distribution; these lists and the paper altogether are indispensable to every student of Post-tertiary Geology, whether of Scotland or any other country.

Dr. Bryce's paper "On the Drift-beds of Arran" is a correction of the Rev. R. B. Watson's statement, that the Arctic shells discovered by him occurred in the Boulder-clay. Dr. Bryce, like other geologists of the West of Scotland, is of opinion that the Boulder-clay proper has not hitherto furnished any fossils; and he examined these Arran Drifts for the purpose of ascertaining whether Dr. Watson's shells really occurred in the Boulder-clay, or on the horizon in which they have been found in Clydesdale, namely, immediately above that deposit. As the result of his researches, Dr. Bryce states that the Arran shells occur in a bed of clay, immediately above the Boulder-clay, and beneath another series of beds, without fossils, which he terms "Upper Drifts." In Clydesdale a bed of laminated clay divides the Shell-bed from the Boulder-clay, the shells are better preserved than in Arran, and shells of British species occur in the "Upper

Drifts;" but in other respects the author draws a parallel between the two series. Dr. Bryce attributes to the Boulder-clay a glacial origin on land, and he ingeniously accounts for the differences in the Arran and Clydesdale series according to his theory of the formation and origin of their remaining members.

The next paper, also by Dr. Bryce, "On Beds in the West of Scotland beneath the Boulder-clay," is the result of an examination into the question whether the Elephant-remains which have been found near Kilmaurs really occurred in the Boulder-clay, or in beds beneath it, and he again succeeds in convincing himself that the Boulder-clay contains no fossils. In all probability Dr. Bryce is right, and the beds in which these Elephant-remains were found, and which occur beneath the Boulder-clay, no doubt come into the Pre-glacial period of Mr. Jamieson, who, by the way, infers in his paper, just noticed, that the Elephants whose remains are said to have occurred in the Boulder-clay must have lived previous to the accumulation of that formation. Dr. Bryce suggests that the strata containing the Elephant-remains may correspond with the Cromer forest-bed; and Mr. Jamieson infers the correlation of certain shell-bearing beds in Aberdeenshire with our English Red Crag.

The Rev. H. W. Crosskey's paper may be considered an appendix to those of Dr. Bryce, as the subject is the same, though the locality is different. In 1850, Mr. Smith, of Jordan Hill, described the occurrence of a bed of clay containing *Tellina calcarea*, intercalated between two masses of true Boulder-clay, and Mr. Crosskey now discusses the question whether the upper mass was really Boulder-clay. He comes to the conclusion that the upper deposit is a wash from a higher ridge of Boulder-clay, and that the shell-bed, which is on the slope of such a ridge, occupies the same position as the common shell-beds of the Glacial epoch in the West of Scotland; at any rate, he submits that the contrary has not been proved.

Considering how often the complaint has been made that the classification of our Post-tertiary deposits is in a more unsatisfactory state than that of any other portion of the geological series, we rejoice to find that the geologists of Scotland are working so hard and so earnestly at the subject; and we sincerely hope that the reproach will soon cease to be applicable to their series. At all events we have in this number of the Society's Journal four papers of very great value, and as they have appeared together, the date of their publication will doubtless mark an epoch in the history of the Post-tertiary beds of Scotland.

The next paper we shall notice is that by Mr. E. Ray Lankester, "On the Sources of the Mammalian Fossils of the Red Crag, and on the Discovery of a new Mammal in that Deposit allied to the Walrus." Its author is a very young palæontologist of great promise, who has already published two or three papers containing descriptions of new mammals from the Red Crag. In pursuing his researches he has been tempted, like some of his predecessors, to speculate on the sources whence this strangely heterogeneous fauna was derived. In the Red Crag we have, as Mr. Lankester remarks, "not one fauna, but a mixture of selections from several." As regards the mammals there are, according to the author, Ziphioid Cetaceans, from the Middle Antwerp Crag, or an equivalent of it; Mastodon, Rhinoceros, Tapir, *Sus, Felis,* &c., from either a late Miocene or an early Pliocene deposit; and *Coryphodon, Hyracotherium,* &c., from our own Eocene deposits. Mr. Lankester does not pretend that his idea is new, as he states that it is merely an extension of the views formerly advanced by Mr. Searles Wood, sen.; but, unfortunately, it is precisely his extension that will be cavilled at, although Professor Owen has published the same opinion in general terms. Judged by the rules which should govern our processes of ratiocination, Mr. Lankester's argument may doubtless be faulty, as exceptions could be taken to most of its terms; but as in Geology we cannot expect, and rarely even attempt, to demonstrate with logical accuracy, so ought we to judge only of the probability of this view being correct, and not whether there cannot be found a loophole of escape for the Crag worshipper and his white elephant to creep through.

We must pass over the remaining papers in this number, several of which are of great interest, to enable us to say a few words on the second part of Dr. Falconer's great memoir "On the Species of Mastodon and Elephant occurring in the Fossil State in Great Britain," which is now published (unfortunately incomplete) posthumously, as a postponed paper, having been read on June 3, 1857. As an abstract of the paper was published in 1858, we shall merely give a very general sketch of what is now published in full. This second part refers entirely to the genus *Elephas,* the genus *Mastodon* having been described in the first part. Dr. Falconer divides *Elephas* into three sub-genera, namely, *Stegodon, Loxodon,* and *Euelephas.* The Stegodons and Loxodons have hypisomerous teeth, that is to say, they deviate from numerical symmetry by an augmentation of one ridge to the crown of the last "intermediate molar." The teeth of *Euelephas* are anisomerous, the ridges being more numerous, and augmenting by progressive increments corresponding with the increase of age. The Loxodons differ from the Stegodons in having the ridges of the teeth considerably more elevated and compressed, the latter sub-genus approaching more nearly to the Mastodons. The existing African elephant is a *Loxodon,* and the existing Indian species belongs to the sub-genus *Euelephas.* Dr. Falconer describes those species which illustrate the extinct English elephants, beginning with the Stegodons; and of our extinct forms he gives a full description of *Elephas* (*Loxodon*) *priscus* and *E.* (*Lox.*) *meridionalis;* he also begins the description of *E.* (*Euelephas*) *primigenius,* but the memoir is, unhappily, wanting in the remainder of the description of this species, as well as in the description of *E.* (*Euelephas*) *antiquus,* and in the general conclusions at which the author had doubtless arrived. These lacunæ are unfortunately the most important portions to English geologists, so that in this posthumous fragment we really have a kind of Pachydermatous "Hamlet"—without the prince.

VII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The 'Mineral Statistics for 1864' have been recently published. This National return may be regarded as the balanced ledger of the mining interests, and we look to it annually for the purpose of learning the progress of several of our most important industries. The way in which the transmuting power of the human mind has been brought to bear, with greater or less force, by the peoples of different countries, is a curious and instructive study. This has been in nearly all cases determined by the abundance of one or the other of the great divisions of the natural kingdom. The products of the vegetable world become the objects of manufacture to one country; those of the animal especially claim the attention of another; while the mineral stores receive the attention of the inhabitants of those lands which are, like our own, especially marked by the variety of rock formations, and, consequently, by the abundance and diversity of its minerals.

We are essentially a manufacturing people, but every branch of manufacture which we have made especially our own, depends upon the vast mineral resources which we possess. Without our coal and our iron, we should fail to maintain our position amongst nations, and although we do not depend so directly on our other metalliferous minerals, yet much of our prosperity and commerical power is to be traced to our mines of tin, of copper, of lead, and of other ores. With a view of showing this, we have made the following careful abstract from the 'Mineral Statistics' for last year. The quantity of coal produced from 3,268 collieries reached the enormous amount of 92,787,873 tons, which is valued at the pit's mouth,—that is, before any cost of carriage is incurred, at 23,196,968*l.* Of this we exported to foreign countries about eight million tons and a half. There is—owing we suppose to the different dates to which the respective returns have been made up—some discrepancy in the statement of the exports given in this book.

	Tons.
The Parliamentary Return gives	8,809,908
The Board of Trade	8,800,420
The General Summary of Exports to all countries, as given in detail .	8,063,846

Whichever return, however, is adopted, there is, in comparison with the returns of the previous year (1863), an increase of rather more than 500,000 tons in our coal exports. From this we learn that our manufactures, our steam engines on land, our steam vessels at sea, our locomotives, and our domestic fires consumed no less than 83,900,000 tons of coal during last year: verily, this is a serious drain upon our stores. Nothing has been published which can be regarded as satisfactory on the question of the duration of our coal fields. We must not, therefore, accept any of the conclusions which have been arrived at as strictly reliable. At the same time, the fact should not be lost sight of, that we are each year increasing the engineering difficulties which accompany the mining for deep coal, and consequently increasing slowly but certainly the cost of production. With the increase of the price of coal to the manufacturer, there must of necessity ensue an advance of price to the consumer of the manufacture, whatsoever it may be. It therefore becomes a necessity to economize the consumption of coal in every direction, and to encourage the invention of machinery, by which the cost of "getting" coal may be, as much as possible, reduced.

Since we noticed in former numbers of the 'Journal of Science' the introduction of machines for cutting coal, several modified forms, of those of which we gave drawings, have been introduced, but there is not sufficient novelty in any of them to lead us, at present, to any special description of them. There is no doubt much ingenuity in several of those machines, but we delay noticing them until they have been perfected by experience in the coal pit.

Our iron produce is certainly next in importance to the coal. 613 Iron furnaces were in blast during 1864. To supply those, 10,064,890 tons of iron ore were required and obtained from our iron mines. From this, and some small parcels of Foreign ore imported, there were smelted 4,767,951 tons of pig-iron. This was distributed over 6,338 puddling furnaces, and by the gigantic aid of 705 rolling mills it was converted into merchant, bar, and other iron. In addition to this, we imported 53,918 tons of iron, most of which was employed in the manufacture of steel; and nearly 8,000 tons of steel of Foreign manufacture were also brought into the country.

In the present number of the Journal a paper appears on British gold. That paper contains the statistics of the production of this precious metal; we have therefore only to state in this place that 2,887 ounces of gold were procured last year from 2,336 tons of quartz, which were mined from the slate rocks of Merionethshire.

Our Cornish and Devonshire mines produced 15,211 tons of tin ore, which yielded of metallic tin 10,108 tons. This is in excess of any former year. It is surprising that, in the face of the evident accumulation of this metal in the hands of the smelters, and consequently, of a constantly falling price, so large a quantity of tin ore (black tin) should be forced upon the market. It is no doubt owing to the very unsatisfactory manner in which our mines are worked, and, to the necessity which exists, for the purpose of maintaining the price of shares, in the mining markets of London, and our other large towns.

The copper mines of the United Kingdom produced 214,604 tons of ore, which gave 13,302 tons of metallic copper. The copper mines of this country are showing evident indications of decline. The quantity of ore sold in 1863 was slightly in excess of 1864, but the metal obtained from it was less, proving that poorer ores are being sent into the market. Our importations of this metal were 93,304 tons, of copper ore and regulus 10,015 tons in bricks and pigs, and 14,924 tons in bars. Of this, by far the largest portion was from Chili and Cuba.

The British lead mines gave 94,433 tons of lead ore, and from this there were obtained 67,081 tons of lead and 641,088 ounces of silver, the value of the lead being 1,448,959*l.*, and of the silver 176,299*l.* The production of Zinc is comparatively small, the total quantity for 1864 amounting to 15,047 tons only, whereas we imported 2,621 tons of Zinc ore and 31,281 tons of Zinc, more or less pure. Our importations of iron pyrites was also much in excess of our production. We need not detail the less valuable minerals; suffice it to say, the total value of the minerals obtained last year was 31,603,047*l.*, the value of the metals produced being 16,281,869*l.*

A Swedish engineer, M. Nobell, has proposed the use of nitro-glycerine instead of gunpowder for blasting purposes in mines. If fired by the electric spark, or the gunpowder match, the explosive force of this compound is considerable. In the course of the discussion in the Academy of Sciences of Paris on the use of this nitro-glycerine, it came out that M. Ascagne Sobrero, a young Italian chemist attached to the laboratory of M. Pelouze, treated in 1847 glycerine by a mixture of nitric and sulphuric acid, and obtained a nitro-glycerine having the aspect of olive oil—yellow, heavier than water, and insoluble in it, but soluble in alcohol and ether, and which possessed all the properties of gun-cotton as an explosive agent. The nitro-glycerine of M. Nobell is said not to detonate at the temperature of 100° Cent., nor by the action of a single spark. A commission, composed of MM. Regnault, Pelouze, Combes, Morin, and Chevreul, has been named to inquire into the application of this fluid for blasting in mines.*

Some experiments have been made in the tin mines of Altenburg, in Saxony, which appear to have been very satisfactory. The great advantages are the smallness of the holes required in the rock, and consequently the great saving of the time in the miner. Gunpowder has, it is stated, but one-tenth the strength of this liquid. The process of blasting with the nitro-glycerine is very easy. If there are any fissures in the rock, the hole or chamber must be first lined with clay, to render it water-tight. This being done, the nitro-glycerine is poured into the hole, a safety fuze, with a well-charged percussion cap, is introduced into it, and the hole is filled with water, no other tamping being necessary. Other experiments have been recently made in the presence of a committee of the Royal Cornwall Polytechnic Society in Cornwall, and the rending powers of this explosive compound has been proved to be most remarkable.

Shale Oil in New South Wales.—In the neighbourhood of Illawara an inflammable substance has been long known to exist. Recent examination has shown that this contains a large quantity of kerosene oil. Some of this shale having been collected and carried to Sydney, it was properly examined and found to be really of considerable value. The quantity of oil yielded by twenty-one pounds of shale, when subjected to distillation, was one gallon. It is stated that this oil can be produced and packed in tins at 1*s.* 6*d.* per gallon.

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* 'L'Institut,' 10th July, 1865. No. 1646.

At the meeting of the Mining Engineers, at Manchester, several matters of great interest to the coal-miner were brought forward and discussed.* There were no questions, however, of sufficient general interest to occupy our space, especially as all the communications and the discussions thereon will be published by the associated societies of Newcastle and South Wales. The value of those meetings is great -and we are surprised, seeing how evident this has been rendered, by the progress of the Institutions of Mining Engineers in Newcastle and South Wales—that they have not been extended. The annual meeting of the Miners' Association of Cornwall and Devonshire was held at Falmouth, on the 31st of August. Several papers on the peculiarities of the mineral districts in Cornwall—on Mine Surveying, and on other allied subjects, were read; and a letter from Mr. Arthur Dean on the presence of gold in some of the Cornish pyritic lodes, especially in the large lode of sulphur ore at Dowgas, near St. Anstell. It was stated by the Honorary Secretary and founder of the Association, Mr. Robert Hunt, F.R.S., that three classes, for the instruction of the working miner in Chemistry and Mineralogy, were progressing most satisfactorily under the guidance of Dr. C. Le Neve Foster.

MINERALOGY.

M. de Zepharovich, of the University of Prague, has transmitted to the Mineralogical Class of the Academy or Sciences at Vienna, a Memoir on the *Bournonite*, *Malachite* and *Corynite* of Olsa, in Carinthia.

The *Corynite* is a new species of pyrites, which is extremely abundant in the sulphate of lime and carbonate of iron of the explored beds of the mine at Olsa. The *Corynite* appears to belong to the nickeliferous pyrites, ranging between *Gersdorffite* and *Ullmannite*, appearing to be a compound of sulphide and arsenide of nickel, combined with a sulphite and antimoniate of nickel. The remarks on the other minerals have no general interest.

A new mineral, Iodide of Lead, has been discovered in Chili, containing 10 per cent. of lead. It is spoken of as being of high commercial value as an ore of lead, independently of the iodine which it contains.

Bismuth in large quantities is now being obtained by a small company of miners, in the Iljampu mountain, only just below the limits of perpetual snow. We alluded, in one of our early numbers, to the use of Bismuth, in some absurd attempts which had been made to transmute the baser metals. The following abstract, from a more extended table, shows the remarkable variations in the price of this metal dependent upon this delusion.

In 1844, Metallic Bismuth was 10*d*. the pound. In 1844 and 1845, it rose to 2*s*. 6*d*., and this price continued to 1858, except on one or two occasions when the price rose to 4*s*. per pound. In 1861, the price of Bismuth suddenly advanced to 9*s*. 6*d*.; and in 1862 it reached 20*s*. the pound; since which time it has fallen back to 10*s*. 6*d*. The principal uses to which this metal is applied, are in the manufacture of fusible metal, of calico-printers' rollers, and for medicinal purposes. This country is supplied chiefly from the Saxon and Bohemian mines. Although found in Cornwall, it is but rarely obtained in sufficient quantities for sale.

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* 'Colliery Guardian,' July 15 and 22.

Professor Goeppert has published a book '*On the Organic Nature of the Diamond.*' The fact that diamonds when exposed to the intense heat of the voltaic arc are turned black—converted indeed into coke—is seized upon to prove that this precious gem cannot have been produced by igneous action. Diamonds are stated by Goeppert to have often on their surface, impressions of grains of sand, and sometimes of crystals, showing, it is contended, that they must have been in a soft state. It is found that sometimes they enclose other crystals, germs of fungi, and occasionally fragments of vegetation of a higher order. All the facts known, according to Professor Goeppert, appear to prove that the diamond is the result of vegetable change, representing, in fact, the ultimate condition of a series of decompositions.

METALLURGY.

A paper, "*Fabrication directe de l'Acier fondu au moyen des Gaz,*" by M. Aristide Bérard, was read at the meeting of the Academy of Sciences in Paris on the 17th July. To produce steel, the impurities of iron are removed by using alternately reducing and oxidizing agents in the gaseous condition. M. Bérard operates in a kind of reverberatory furnace with two soles, which are separated by a bridge; coke is placed on this bridge to remove free oxygen. While air is sent through the metal on one side, the other is treated with a mixture of hydrogen and carbonic oxide free from sulphur. The process is supposed to be thus explained:—During the period of oxidation part of the iron is converted into protoxide—the earthy metalloids—such as Silicium, Aluminium, Calcium, and the like, are oxidized, and combined with Silica to form Slags. The sulphur, phosphorus, and arsenic are oxidized and volatilized. In the period of reduction the oxide of iron is reduced, and the other metals remain in combination with the Silica, forming *Scoriæ*, which float on the surface. Any sulphur, phosphorus, or arsenic remaining is said to form now a volatile hydrogen compound. The final process is that of decarburation, which is effected by the air-blast. This process appears to us to partake, in all its main features, of the principles involved in that of Bessemer. It certainly involves many of the conditions which were experimented on, and rejected, ere the Bessemer process took its final form. We are also told that Manganese plays an indefinite part; the certain effect, however, being to facilitate the conversion of the iron into steel. Is this anything beyond the use of *Spiegel-Eisen?* The French Metallurgists are still continuing the discussion on the agents necessary for the production of cast-iron and steel. M. Marguerritte recently published a memoir on this subject, in which he gave many original and ingenious experiments. MM. Boivin and Loiseau have communicated to 'Les Mondes' some experiments which they think are confirmatory of the views entertained by M. Marguerritte. They suppose the carburet of iron to be a definite compound, which is infinitely soluble in melted iron. Many of the experiments certainly appear to support this view, but there are many reasons why we hesitate to accept this explanation as the decision of a complicated problem.

M. Troost has interested the Academy of Sciences at Paris by an account of the process by which he has succeeded in obtaining the metal *Zirconium*. It will be remembered, by most of our readers, that the delicately tinted gem, the *hyacinth Zircon*, commonly called the *jargon*, contains this metal, which was separated by Berzelius, but which has not, before the experiments by M. Troost, been produced in a coherent form. By heating the double fluoride of Zirconium and potassium with one part and a half of aluminium, to a temperature required for melting iron, in a crucible made of gas retort charcoal, crystalline laminæ of Zirconium are formed around the button of Aluminium. From these the Aluminium can be removed by means of diluted Hydro-chloric Acid.

The pure metal thus obtained is a very hard substance of the colour of antimony, and much resembling it in lustre and brittleness. The density of crystallized Zirconium is 4·15 ; it is not attacked by either Sulphuric or Nitric Acids at ordinary temperatures, but is readily dissolved by Hydro-fluoric Acid. It is a bad conductor of electricity. M. Troost is still continuing his investigations, and we may therefore expect to know more of this rare and curious metal in a short time.

Our French neighbours boast of a new application of centrifugal force. Iron tubes are now made by calling this power into play. Into a cylinder of the required size, closed at each end, the necessary quantity of melted iron is poured, and a rapid motion is communicated to it. The melted metal is pressed against the sides of the cylinder; it cools while in motion, and the result is a perfectly uniform and straight tube. The machine is invented by a young workman named Auguste Larson, and the writer says* that the first trials are perfectly successful. For many years a similar process has been employed in this country, especially for small ornamental castings. The cylindrical casings of the oil vessels of the Moderator Lamps have been so made. The melted copper or bronze is poured into a cylindrical mould, which, being closed, is allowed to roll down an incline plane; here centrifugal force is called into play, and remarkably sharp castings are the result.

A very important experiment is about to be tried, on a sufficiently large scale, to determine its commercial value, by Messrs. Vivian and Sons, of Swansea. The "copper smoke" so called, which envelopes the town and destroys the vegetation in the valley and on the hills around it, is produced by the volatilization of sulphur from the copper ores which are smelted in the numerous and extensive works which are located on the margin of Swansea Bay. An eminent authority writes "that 46,000 tons of sulphur are volatilized into 92,000 tons of sulphuric acid; that in the neighbourhood of Swansea 65,900 cubic metres, or nearly two millions and a half cubic feet, are projected into the atmosphere; and Le Play estimates the value of the sulphur dissipated at 200,000*l.* yearly."

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* 'Les Mondes,' 20th July, 1865, p. 468.

M. Moritz Gerstenhöfer has invented a furnace, by means of which a considerable portion of this sulphur will be converted into a marketable product. Mr. Hussey Vivian writes, "We have had two calciners at work for some months, and are now building twenty-six more. As far as I can form an opinion, it (Gerstenhöfer's calciner) is a perfect success, and will put an end to all vapours arising from our calcining and roasting furnaces. I believe that when this furnace is universally adopted, the only vapours arising from our copper works will be those of the melting furnaces. At a rough guess, probably upwards of two-thirds will be condensed and turned to profitable account." The ores of copper smelted are usually oxides, carbonates, and sulphides. The two former produce no injurious consequences, but the latter, which is by far the most abundantly used, fills the air with sulphur vapour. In Gerstenhöfer's furnace the ore is so divided as it passes from the regulated hoppers at the top, that it shall fall on a triangular bar, and then on to similar bars below each other, and thus expose the ore to continued subdivision, till it reaches the bottom and is freed from the sulphur. The heat and oxygen converts it into sulphurous acid, which is constantly passing off through the side into leaden chambers, where it gets an additional supply of oxygen in the usual manner, and is collected as oil of vitriol. In the process no additional fuel is required, for the sulphur catching fire at the upper bars, the heat evolved suffices to keep the falling ore in a state of ignition.

Puddling by machinery appears to be making certain, although slow, advances. The apparatus erected at Dowlais by Mr. Menelaus is, by all who have seen it at work, pronounced to be, mechanically, perfect. The defect of the arrangement at present being the difficulty of securing the lining of the pear-shaped revolving furnace. This is thought by most ironmasters to be a difficulty which will be remedied after a little more experience has been gained.

A Swedish chemist has discovered a method of reducing the ores of Tungsten, and of obtaining the metal at once in a state of fusion. It is stated that ingots of the pure metal weighing several pounds are now shown in Stockholm, and that by the new method the cost of obtaining tungsten does not exceed a few shillings the pound.* Since this metal is found to give great toughness to iron, it may become very valuable as an alloying agent, and this process may be of importance. At Drake Walls, at Kit Hill, and East Pool, in Cornwall, almost any quantities of wolfram can be obtained, and if brought into use, that which is now a waste material and an annoyance, would become both useful and profitable.

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* 'Mechanics' Magazine.'

VIII. PHYSICS.

LIGHT.—With few exceptions spectroscopes and spectrum observations constitute the principal novelties in this branch of science, during the last few months. Foremost among the latter may be mentioned a lecture by Mr. Huggins, delivered before the Royal Institution, on the physical and chemical constitution of the fixed stars and nebulæ. The speaker stated that spectra might be divided into three orders, *viz.*:—

1. A continuous spectrum, unbroken by bright or dark lines, which indicates that the light has not undergone any modification on its way to us. Also, that its source is an opaque body, almost certainly in the solid or liquid state. Such a spectrum gives no information of the chemical nature of the substance from which the light emanates.

2. A spectrum of bright lines separated by dark spaces; this informs us that the source of the light is matter in the gaseous state. By a comparison of the bright lines of such a spectrum with the lines of terrestrial flames we may discover whether any of these terrestrial substances exist in the distant and unknown source of light. The spectra of many of the nebulæ are of this order.

3. A continuous spectrum interrupted by dark lines; this shows that the light has passed through vapours which have deprived it of certain refrangibilities by a power of selective absorption.

Since Kirchhoff has shown that these dark lines agree exactly in position with the bright lines which the vapours would emit if in a luminous state, a comparison of these dark lines with the bright lines of terrestrial vapours will indicate whether any of these are present in the vapours through which the light has passed. The spectra of the fixed stars are of this order. In the case of these bodies, the vapours that produce the dark lines immediately surround them, and are those of the substances of their surfaces. The chemical constitution of the stellar atmospheres will correspond, at least in part, with that of the stars themselves.

What are the stars? Endeavour with the most powerful telescopes to approach them, still they assume no apparent size; they remain under the highest magnifying powers what they appear to the unaided eye—diskless, brilliant points.

Until quite recently, our knowledge of the stars might be summed up thus:—That they shine; that they are immensely distant; that the motions of some of them show them to be composed of matter endowed with a power of mutual attraction.

Since these bodies are self-luminous, we may hope to gain by prismatic analysis more information of their nature, than it is possible to do of the planets, which all shine by reflecting the sun's light.

The results on the light of the stars Aldebaran and α Orionis (Betelgeux) are given in the following table:—

Elements Compared with Aldebaran.

Coincident.		Not Coincident.	
1. Hydrogen	with lines C and F	Nitrogen	three lines
2. Sodium	„ double line D	Cobalt	two lines
3. Magnesium	„ triple line *b*	Tin	five lines
4. Calcium	„ four lines	Lead	two lines
5. Iron	„ four lines and E	Cadmium	three lines
6. Bismuth	„ four lines	Barium	two lines
7. Tellurium	„ four lines	Lithium	one line
8. Antimony	„ three lines		
9. Mercury	„ four lines		

70 lines measured.

Elements Compared with α Orionis (Betelgeux).

Coincident.		Not Coincident.	
1. Sodium	with double line D	Hydrogen	C and F
2. Magnesium	„ triple line *b*	Nitrogen	three lines
3. Calcium	„ four lines	Tin	five lines
4. Iron	„ three lines and E	Lead	two lines
5. Bismuth	„ four lines	Gold?	
6. Thallium?	„	Cadmium	three lines
		Silver	two lines
		Mercury	four lines
		Barium	two lines
		Lithium	one line

80 lines measured.

The 70 or 80 lines measured represent some of the stronger only of the numerous lines which are seen in the spectra of these stars. Some of these are probably due to the vapours of other terrestrial elements which have not been compared with these stars. It would be assumption to suppose that the sixty-five so-called elements constitute in its entirety the primary material of the universe. Doubtless in the spectra of the stars the chemist is introduced to many new elements—would that it were possible for him to recognize and to isolate them!

From the additional knowledge which these spectrum observations give us, we are entitled to conclude that in plan of structure the stars closely resemble the sun. The source of their light is probably solid matter, in a highly incandescent state. Around this photosphere, there exists an atmosphere of vapours of such of the elements of the stars as are volatile at their high temperature.

A community of matter appears to exist throughout the visible universe, for the stars contain many of the elements which exist in the sun and earth.

It is remarkable that the elements most widely diffused through the host of stars are some of those most closely connected with the living organisms of our globe, including hydrogen, sodium, magnesium, and iron.

Spectrum observations applied to the nebulæ appear to authorize the following opinions of the nature and structure of those of the nebulæ which gave a spectrum of bright lines:—

1. The light from these nebulæ emanates from intensely heated matter existing in the state of gas. This conclusion is corroborated

by the great feebleness which distinguishes the light from the nebulæ. A circular portion of the sun's disk subtending 1′ would give a light equal to 780 full moons, yet many of the nebulæ, though they subtend a much larger angle, are invisible to the naked eye.* Upon the earth, luminous gas emits a light which is very inferior in splendour to incandescent solid matter.

2. If these enormous masses of gas are luminous throughout, the light from the portions of gas beyond the surface visible to us would be in a great measure extinguished by the absorption of the gas through which it would have to pass. These gaseous nebulæ would, therefore, present to us little more than a luminous surface. This consideration may assist in explaining the strange apparent forms of some of the nebulæ.

3. It is probable that two of the constituents of these nebulæ are the elements, hydrogen and nitrogen, unless the absence of the other lines of the spectrum of nitrogen indicates a form of matter more elementary than nitrogen. The third gaseous substance is at present unrecognized.

4. The uniformity and extreme simplicity of the spectra of all these nebulæ oppose the opinion that this gaseous matter represents the "nebulous fluid" suggested by Sir William Herschel, out of which stars are elaborated by a process of subsidence and condensation. In such a primordial fluid all the elements entering into the composition of the stars should be found. If these existed in these nebulæ, the spectra of their light would be as crowded with bright lines as the stellar spectra are with dark lines.

The supposition can scarcely be entertained that the three bright lines indicate a more primary and simple condition of matter; for then, if the process of elaboration into stars be now taking place, we should expect to find in some of the nebulæ, or in some parts of them, a more advanced state towards the formation of the separate elements of which we now know the stars to consist. Such an advance would be indicated by an increased number of bright lines. It is difficult to suppose that the excessively high temperature of the nebulæ keeps in check affinities by which, if unrestrained, the formation of the elements would take place; for in some of the nebulæ a nucleus exists, which from its continous spectrum, its greater brightness, and apparent separation from the surrounding gas, we must regard as containing solid or liquid matter. At a temperature at which matter can become liquid or solid (though from peculiar conditions that temperature may be a very exalted one), we cannot suppose the formation of the chemical elements to be restrained by excessive heat.

5. A progressive formation of some character is suggested by the presence of more condensed portions, and in some nebulæ, of a nucleus. Nebulæ, which give a continuous spectrum, and yet show but little indication of resolvability, such as the great nebula in Andromeda, are not necessarily clusters of stars. They may be

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* See 'Outlines of Astronomy,' by Sir John F. W. Herschel, p. 616. Seventh edition.

gaseous nebulæ, which by the loss of heat or the influence of other forces have become crowded with portions of matter in a more condensed and opaque condition.

6. If the observations of Lord Rosse, Professor Bond, and others are accepted in favour of the partial resolution of the annular nebula in Lyra, and the great nebula in Orion into discrete bright points, these nebulæ must be regarded not as simple masses of gas, but as systems formed by the aggregation of gaseous masses. Is it possible that the permanence of general form of these nebulæ may be maintained by the motions of these separate masses?

7. The opinion of the enormous distance of the nebulæ from our system, since it has been founded upon the supposed extent of remoteness at which stars of considerable brightness would cease to be separately visible in our telescopes, has no longer any foundation on which to rest in reference at least to those of the nebulæ which give a spectrum of bright lines. It may be that some of these are not more distant from us than the brighter stars.

8. As far as the speaker's observations extended, they appeared to be in favour of the opinion that these nebulæ are gaseous systems possessing a structure and a purpose in relation to the universe altogether distinct from the great cosmical masses to which the sun and the fixed stars belong. What is this special purpose? Many fascinating theories present themselves in connection with the great problems of the conservation of the energy of the universe, and of the source and maintenance of solar and stellar heat. In the opinion of the speaker, science will be more advanced by the slow and laborious accumulation of facts than by the easier feat of throwing off brilliant speculations.

A paper on the spectrum of nitrogen was sent by Mr. Waltenhofen to a recent meeting of the French Academy, in which he states that in an atmosphere of nitrogen properly rarefied the violet rays disappear before the blue and green. The author's observations lead him to believe that nitrogen is a compound body.

Professor J. Müller has examined the wave length of the blue indium line, by the method and by means of the grating which the author described some time ago. He finds it to be 0·000455 millim.

When the light of an indium flame is decomposed by the prism it shows *two* blue lines, one of which, very intense, is situated close to the blue strontium line, but a little further towards the violet end of the spectrum; the other line is still more refrangible, but so much fainter that it cannot be perceived at all in the spectrum produced by means of a grating.

A valuable application of the spectroscope to toxicological purposes has been made by Hoppe-Seyler, who has described it before the French Academy. He applies it to the recognition of poisoning by carbonic oxide. The method is founded on the following observation:—Blood treated with carbonic oxide alone shows the same spectrum as blood containing oxygen, and, if sulphide of ammonium be added, no change will take place even after several days; but if blood which contains only oxygen in solution is treated with sulphide of ammonium, an almost immediate change takes place, and only one band is seen about midway between **D** and **E**. By this unchangeability of blood holding carbonic oxide in solution on the addition of sulphide of ammonium, the author detects the presence of the poisonous gas. It is worth quoting that the author has found that, by continuing artificial respiration for a time, animals poisoned by carbonic oxide have been restored to consciousness, the gas being expired as carbonic acid.

Mr. Gassiot has communicated to the Royal Society a description of a rigid spectroscope, which he has had constructed with a view to ascertain whether the position of the known and well-defined lines of a spectrum is constant, while the co-efficient of terrestrial gravity under which the observations are taken is made to vary. The idea of it was suggested by Professor Tait and Mr. Stewart, and Mr. Browning was consulted as to the practicability of constructing the spectroscope. He considered such an instrument could be made, with sufficient rigidity in all its parts, to examine with great accuracy any given portion of the spectrum which might be selected, and for which the prisms would have to be adjusted and fixed. The observations having been originally intended to be made in balloon ascents, the construction of the spectroscope had necessarily to be considered in reference to some portable and easily manageable form, and it was particularly desirable that its weight should be as low as possible. The instrument was completed so as to weigh little more than 40 lbs., but it was soon found that the errors arising from changes in the temperature were so variable, that no good results could have been obtained in balloon ascents, where rapid fluctuations of temperature would continually occur; it was then determined to attempt the construction of a rigid spectroscope, with which observations might be made, either on board a vessel or on land in various latitudes, and as the question of the total weight of the apparatus became no longer of paramount importance, an alteration in the construction of the instrument was decided upon. Three large prisms are used, with sides 2½ inches high and 3 inches long, the light being reflected back through them, so as to make the whole equal to that which would be produced by five prisms if employed in the ordinary manner. Thermometers were inserted into holes drilled in the prisms, so that the exact temperature of these and also of the surrounding atmosphere can be taken. The performance of the instrument is very satisfactory; Mr. W. Huggins has seen two bright lines between the **D** lines produced by the flame of a common spirit lamp; and several persons have seen on different occasions from five to seven lines between the **D** lines in the solar spectrum. This is equal to the performance of the large spectroscope, with which the solar spectrum is now being mapped at Kew Observatory. Numerous observations of the different readings of one of the **D** lines for variations of temperature are given, and the result of observing under a varied temperature of 40° Fahr., the carrying of the instrument from the Minories to Kew Observatory, and subsequently to the Royal Society without affecting the readings may be taken as evidence that with ordinary care the spectroscope can now be used with reliance as to the rigidity of its construction, thus fulfilling the conditions which are indispensable for obtaining correct observations.

HEAT.—In a former number we gave a brief account of some experiments by Professor Tait and Mr. Stewart on the phenomenon of the heating of a disc by rapid rotation; some further results have lately been communicated by these gentlemen to the Royal Society. In their apparatus a slowly revolving shaft is carried up through a barometer tube, having at its top the receiver which it is wished to exhaust. When the exhaustion has taken place it is evident that this shaft will revolve in Mercury. In the receiver the shaft is connected with a train of toothed wheels, and ultimately causes a circular disc to revolve 125 times for each revolution of the shaft. Two insulated wires, connected with a Thompson's reflecting galvanometer, are carried through two holes in the bed-plate of the receiver, and are then connected with a thermo-electric pile having the usual reflecting cone attached to it. The outside of the pile and of its attached cone is wrapped round with wadding and cloth, so as to be entirely out of the reach of currents of air. The vacuum-gauge is on the syphon principle, and there is every reason to believe that it is perfectly deprived of air; and it is only necessary to add, that the whole is covered over with an airtight glass shade, 15 inches in diameter and 16 inches high. The galvanometer and thermo-electric pile were sufficiently delicate, that if the temperature of the disc were to rise 1° Fahr. this would be denoted by a change in the position of the line of light equal to fifty divisions of the scale. In these experiments the disc is rotated rapidly for half a minute, making 2,500 revolutions, and the heating effect was recorded by the pile. The object of this paper is to investigate the origin of this heating effect. In the endeavour to account for this result, the authors consider that we are reduced to choose between one of two causes or to a mixture of the two.

1. It may be due to the air which cannot be entirely got rid of.
2. It is possible that visible motion becomes dissipated by an ethereal medium, in the same manner and possibly to nearly the same extent as molecular motion, or that motion which constitutes heat.
3. Or the effect may be due partly to air and partly to ether.

The authors give experiments to prove that only a very inconsiderable portion of the effect observed depends upon the mass of air left behind; neither does the effect appear to be due to fluid friction.

M. Dufour, of Lausanne, has made some experiments to ascertain whether other gases behaved like atmospheric air in the phenomenon of ebullition under different pressures. He employed hydrogen, carbonic acid, and coal gas, and found that when water saturated with either of these gases was heated to boiling in an atmosphere of the same gas, the phenomenon proceeded exactly as if the liquid were in the presence of air. The ebullition showed nothing unusual, and the temperature at which it took place was only raised one or two degrees. He concludes that the difficulty gases have in quitting liquids holding them in solution comes of a purely physical adhesion, and not of a chemical affinity.

A paper by M. Fizeau, on the Dilatation of the Diamond, and Crystallized Protoxide of Copper under the influence of heat, presented to the Academy of Sciences at their sitting in June last, contains some curious observations.

The author finds that these bodies, like water, present a maximum of density at a certain temperature. The diamond, for example, has its maximum at – 38·8° C., and protoxide of copper at 4°. M. Fizeau has also determined the co-efficients of dilatation in these two bodies. These are the first two solid bodies in which the maximum of density has been satisfactorily determined, although the probability of a variation with temperature has been shown.

The thermic equivalent of magnesium has been determined by Dr. T. Woods,* by a method described by him in 1852, namely, by dissolving the metal in dilute sulphuric acid, marking the rise of temperature of the fluid and correcting the result by making the proper allowances for the heat absorbed by the decomposition of the water, and that evolved by the combination of the magnesia with the acid. The result at which the author has arrived, is that the quantity of heat developed by the combustion or oxidation of an equivalent of magnesium is exactly twice as much as that produced by the oxidation of an equivalent of zinc. Zinc will raise the temperature of 1,000 grains of water 9·6° Fahr. by the combustion of 4 grains or 1 equivalent, oxygen = 1. Magnesium by the combustion of 1½ grains, or 1 equivalent, will raise the temperature of 1,000 grains of water 19·2° Fahr. This is the greatest amount of heat produced by an equivalent of any substance with which we are acquainted.

A useful paper on the easily fusible alloys of cadmium has been published by Dr. C. R. von Hauer. The alloys were made by fusing the ingredients in a covered porcelain crucible at the lowest possible temperature. After stirring with a glass rod, the fused mass was poured upon a cold metal plate, where it instantly solidified. The specific gravity and the melting point were determined after the alloy had been so melted and cooled two or three times. In the two or three fusions a partial oxidation of the metals takes place, which occasions a slight alteration in the equivalent proportions, and which it is almost impossible to avoid. The melting point was determined under hot water, and also by placing a thermometer in the fused mass without water. Under water the alloys quickly oxidize. They have also the property of becoming pasty below their proper melting point, which may lead to error in the determinations. The author's determinations were made when the alloy was really fluid.

The following table gives the equivalent proportions of the ingredients in some of the more easily fusible alloys with their melting points:—

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* 'Phil. Mag.,' July, 1865.

Equivalent proportions.	Melting point.
Cd Sn Pb Bi	68·5°C
Cd Sn_2 Pb_2 Bi_2	68·5°C
Cd_3 Sn_4 Pb_4 Bi_4	67·5°C
Cd_4 Sn_5 Pb_5 Bi_5	65·5°C

Lipowitz states that an alloy composed of three parts by weight of Cd, 4Sn, 8Pb, and 15Bi melts at 60°C; but the author of this paper observes that such a compound only becomes perfectly fluid at 70° C.

The melting point of an alloy of two parts Cd, 3Sn, 11Pb, and 16Bi is still higher—namely, 76·5°C.

The following mixtures had the same melting point:—

One part by weight of	Cd, 2Sn, 3Bi	perfectly fluid at 95°C
Two parts „	Cd, 3Sn, 5Bi	
One part „	Cd, 1Sn, 2Bi	

The author adds the following determinations of melting points:—

Proportions.	Melting point.
1 part Cd, 6Pb, 7Bi	88°C
Cd, 2Bi, 3Pb	89·5°C
2Cd, 4Bi, 7Pb	95°C

MM. Ste Claire Deville, Caron, and Troost have communicated a paper to the Academy of Sciences, in which they give their method of making rubies artificially. Fluoride of aluminium, with a small quantity of fluoride of chromium, is placed in an earthern crucible, which has been carefully lined with calcined alumina, just in the same way as a crucible is lined with charcoal. In the centre of this crucible is one of platinum, containing the boracic acid, around which the fluorides are disposed. The outer crucible is well covered. When this apparatus is exposed to a temperature sufficiently high, the fluorides volatilize, and come in contact with the vapours of boracic acid from the inner crucible, above and around which the rubies are deposited. The violet red tint of these is said to be exactly like that of the most beautiful natural stones.

In a memoir on the extraction of sugar, by M. Alvaro Reynoso, of Havanna, read before the French Academy, he gives a most ingenious utilization of the effects of cold in getting rid of the bulk of the water in the juice. By a process described in his memoir, he submits the juice to a very low temperature, and so gets a magma, composed of thick syrup and little lumps of ice. He separates the syrup from these by means of a centrifugal machine, and then evaporates quickly *in vacuo*.

A very ingenious addition has been made to the Lenoir engine by M. Arbos. The engine would often be extremely useful where gas could not be procured, and to make coal-gas would be impracticable. In a very simple apparatus M. Arbos vaporizes water, and passes the vapour over red-hot charcoal dust. The mixture of carbonic acid, carbonic oxide, and hydrogen produced is then passed through milk of lime, to remove the first, and the other two go on to be mixed with air, and exploded in the cylinder of the engine. Extending the use of the engine as mentioned above, M. Arbos's apparatus effects a great saving in the cost of working the machine. Gas produced for two francs will do the work of six or eight francs' worth of coal gas.

A new combustible has been invented by a gentleman appropriately named Stoker, which is likely to possess some useful properties. It appears to be very pure charcoal, finely ground and made into a paste with starch. The paste is moulded into cakes or balls of different sizes, and then dried. When perfectly dry these may be lighted with a lucifer match, and will continue to burn steadily, like German tinder, without giving flame or smoke. The combustible is intended for heating urns, chaufferettes, &c.

ELECTRICITY.—In our last "Chronicles" we gave a brief account of a theory of imponderables, laid before the Academy of Sciences by M. G. Martin. In reference to this subject, two communications have reached us from gentlemen who consider the theories there put forward as sufficiently valuable to be worth claiming, on the ground of previous publication. The first is from Mr. McGauley, who it seems sent a memoir, in which this theory was developed, to the Academy, in May, 1862. It was then referred to a commission, consisting of MM. Pouillet and Fizeau, who have never reported upon it. In an article in the 'Scientific Review' the author states that "three years have confirmed the conviction his researches had long led him to entertain, that the imponderables are really material elements, subject, like all others, to definite laws of combination." We extract the propositions laid down by the author at the commencement of his memoir :—

"*Motion, Electricity, Heat, and Light, consist of the same Constituents, either Singly or in Combination.*

"I. The simplest form of motion (including nervous energy), electricity, heat, and light, is an element of motion in the latent state—that is, combined with matter.

"II. When an element of motion is liberated from combination with matter, by the neutralizing action of a motive element of the opposite kind—that is, 'when two opposite motions destroy each other,' the two electricities are set free, and when these combine, Heat is the result.

"III. When one of the calorific elements is in excess (being combined as a motive-element), the resulting heat becomes either one of the coloured rays of the solar spectrum, or an actinic ray, according to the amount of such excess, and is the more refrangible in proportion to that amount. And it is probable that the nature of the light which results depends on which calorific element (electric element) is in excess.

"IV. Both the heat elements are set free, under the form of the two electricities, during ordinary combustion, but only one of them during galvanic action.

"V. Motion is never produced, except by decomposition of heat, or by liberation of the calorific elements, during chemical action, which is true, even when the decomposition is due to electricity or electro-magnetism. And motion is never destroyed without heat being formed again, except when the calorific elements are prevented from uniting."

The second communication on this subject is from Mr. A. J. Cameron. In this letter the author says, that many years ago, in a paper which was read by Professor Gregory, and also by several others, he *demonstrated* that the two electricities when uniting formed caloric; but more than this was shown, for it would appear that after they had combined, they formed *all kinds of matter*, solid, liquid, and gaseous! We think Mr. Cameron has certainly no reason to accuse either Mr. Martin or Mr. McGauley of having anticipated him in that discovery.

M. Becquerel has published some new observations on thermo-electric piles of sulphide of copper. The author first described the way in which he prepared the sulphide of copper. He places a quantity of sulphur in a crucible and heats it to fusion. When this occurs, which is known by the escape of sulphur vapour, he immerses in the melted sulphur a plate of copper previously heated to dull redness, and leaves it in the crucible until all the sulphur is volatilized. He then removes the plate of copper coated with sulphide, cools it rapidly by dipping it into cold water, and finally detaches the coating of sulphide. This is then fused and run into bars or plates for the pile. As a negative element he employs *maillechort* (a nickel alloy resembling argentine). The author remarks that bars made of the same sulphide show a very unequal action, and that they should be tested before employed for a battery. In a note he mentions that Rhumkorff has found that the addition of $\frac{1}{25}$th of sulphide of antimony renders the action regular, although it somewhat diminishes the power. The ends of the bars of sulphide must be encased by the metal to prevent reduction when heat is applied direct, as by a gas flame. The author next proves that the current is developed by differences of temperature, and not by any chemical change in the sulphide, by showing that a battery has kept in action for a month with one extremity near the melting point of lead without loss of weight in the bar of sulphide of copper. M. Becquerel goes on to compare the electro-motive force of this battery with other thermo-electric piles, and shows that its power is much higher than that of the alloy of antimony and zinc employed by Marcus. It is only available, however, when the effects of tension are required.

In some curious statistics on the subject of death by lightning, given in a note by M. Boudin before the French Academy, it appears that during the period 1835–1863, 2,238 individuals were killed in France. The most in one year was 111; the fewest, 48. Among the

880 persons killed from 1854 to 1863, only 243 were females, which will be 26·7 per cent. In England the proportion of females killed is only 21·6 per cent. In many cases, M. Boudin says, when the lightning has fallen upon a group of people of both sexes, it has only killed the males and spared the females.

In several cases, however, when the electric fluid has fallen upon a flock attended by shepherds, it has only killed the sheep and spared the shepherds. M. Boudin states that there have been many instances of beeches struck with lightning, and that there are at least two examples of individuals struck more than once in the course of their lives; one man, indeed, was struck three times in as many different parts of his body, and another man was struck twice in his left foot. The statistics prove the danger of standing under trees in a storm.

M. Boudin also relates two instances in which the corpses of individuals killed by lightning seemed to be charged with electricity like Leyden jars, for in each instance people going to the assistance of the deceased received violent shocks.

IX. ZOOLOGY AND ANIMAL PHYSIOLOGY, ETC.

DR. RICHARDSON has recently communicated to the Royal Society a very remarkable Memoir, on the possibility of restoring the life of warm-blooded animals in certain cases where the respiration, circulation, and ordinary manifestations of organic motion are exhausted or have ceased. The object of the inquiry was to discover the best means to be adopted for fanning into active life the animal fire which is expiring but is not suspended; and secondarily to solve the question, whether animal combustion cannot be re-established when it appears to have been extinguished; and whether so-called vital activity would not be spontaneously manifested upon such re-establishment of animal combustion. The author is led to the conclusion, which he thinks admits of direct demonstration, that artificial respiration, in whatever way performed, is quite useless from the moment when the right side of the heart fails in propelling a current of blood over the pulmonic circuit, and when the auriculo-ventricular valve loses its tension on contraction of the ventricle. Only is artificial respiration useful when the blood from the heart is being still distributed over the capillary surface of the lungs—the process is simply one of fanning an expiring flame, which once expired will not, in spite of any amount of fanning, re-light. The further conclusion to which he is led goes, however, beyond the process of artificial respiration: returning again to the same simile, Dr. Richardson ventures to report that, even when the heart has ceased to supply blood to the pulmonic capillaries, during the period previous to coagulation, the blood may be driven or drawn over the pulmonic circuit, may be oxidized in its course, may reach the left side of the heart, may be distributed over the arteries; and that, thus distributed, it possesses the power of restoring general muscular irritability and the external manifestations of life. Hence he infers that resuscitation, under the limitations named, is a possible process, and that it demands only the elements of time, experiment, and patience for its development into a demonstrable fact in modern science. We have not space to follow Dr. Richardson through the systematic series of experiments which lead to this result, but we may add, that the present memoir is preliminary, and that he promises to return with new results which are in course of development. One very remarkable circumstance may be recorded, which in the author's words is as follows:—"Since this paper was laid before the Society I have determined, by a direct experiment, that *rhythmic stroke* is of the first importance (in artificial circulation) for restoring muscular contraction. By means of a machine, which can be worked either by the hand or by electro-magnetism, I was enabled, assisted by my friends Drs. Wood and Sedgewick, to introduce blood heated to 90° Fahr. into the coronary arteries of a dog by rhythmic stroke, and at the same rate as the stroke of the heart of the animal previously to its death. The result was that in one hour and five minutes after the complete death of the animal, its heart, perfectly still, cold and partly rigid, relaxed, and exhibited for twenty minutes active muscular motion, auricular and ventricular. The action, which continued for a short time after the rhythmic injection was withheld, was renewed several times by simply re-establishing the injection.

Mr. Blyth, writing to the 'Natural History Review,' gives some remarkable instances of the reappearance of lions in some parts of India, from which they were supposed to be extirpated. He observes that during the whole of his twenty-two years' residence in India, not a single instance had been recorded of a lion having been observed in any part of the country, excepting in the province of Kattywar, in the peninsula of Guzerat, to which locality, in the general opinion of sportsmen and others, the species is now restricted as an Indian animal. The lion was supposed to be extirpated in Harriana in 1824; one was killed in the Nerbudda territory so late as 1847–8; since which it does not appear to have been heard of in those parts until last year, when in August, Lieut. Clarke, R.A., was out shooting near Dusay, on the borders of Rajpootana, and was sadly mangled by a lioness, and had to suffer amputation of his right arm. Later, in 1865, March 19th, Lieut.-Col. Tytler writes that a party of officers were out shooting small game on foot, when to their horror three lions sprang out before them, two males and a female. They fired: one of the males fell dead and the other wounded, and was found dead next day. Lions had not been heard of in that part of the country for at least thirty years.

Dr. Davy, in the Proceedings of the Royal Society, gives the results of his observations upon the temperature of the common fowl, made at different seasons of the year, showing that the temperature of this bird ranges from 107° to 109°, and that the male possesses a somewhat higher temperature than the female. Hunter assigned to it a temperature no higher than between 103° and 104°, a degree reached and even exceeded by some mammals. He also gives the results of his experiments on the air expired by a certain number of birds, and on the length of time birds are capable of retaining life under water, which varies much in different species,—being in the duck as much as ten minutes.

We read in the 'Comptes Rendus' an account of the reproduction of some Mexican Axolotls in the Jardin des Plantes, as observed by M. Auguste Dumeril. This being the first time that such an event has taken place under scientific eyes, is a matter of great interest. The ovum is at first similar in appearance to those of other batrachian reptiles, and consists of a black vitelline sphere contained in the centre of a clear vitelline membrane, which is itself contained within an albuminous envelope. The young embryo, in about twenty-eight or thirty days after spawning, becomes separated from the shell, by the aid of violent movements, and then measures 0·015 of a millimetre, and possesses branchiæ which are much less elaborate in their divisions and ramifications than they become in the adult form. A second stage of development may be reckoned, embracing the period when the posterior pair of limbs appears, but M. Dumeril has not yet precisely made out how long elapses between this period and the rupture of the egg. The anterior pair makes its appearance in the earliest stage, but some months pass before the posterior limbs are developed.

M. Poluta, in the 'Annales des Sciences,' gives the results of some researches upon the duration of the life of fishes out of the water, which varies greatly, so that while the sturgeon will exist several hours deprived of its natural element, it is well known that the herring dies in about a minute. This circumstance is not dependent upon a different structure of the respiratory organs, but upon the tenacity of life in the animal fibre, which is in inverse relation to the quantity of oxygen necessary to the support of life in the organism. The herring requires more oxygen for the same weight of body than the sturgeon; and the circumstances which appear to prolong the life of fishes out of the water appear to be these, *viz.* the cylindrical form of the body, the presence of water in the branchial chambers, and the absence of scales from the skin; while the lateral compression of the body, the aggregation of the leaves of the branchiæ in a mass, and the existence of scales have a contrary effect: for fishes with cylindrical bodies, when removed from the water, rest tranquilly upon the ground, and their branchiæ have free play, while the laterally compressed fishes lie upon the side, and cannot distend the branchiæ of the lower side. With regard to the scales, those fishes which have them most deeply implanted in the skin live longest, while those in which they readily separate, as the herring, are very short lived; and the same circumstances may be observed in the case of lizards, tortoises, &c., whose tenacity of life is very great, and in inverse relation with the quantity of oxygen necessary to sustain life, while it is in direct relation to the depth of implantation of their scales.

The operculum of univalve shells has given rise to different opinions as to its homologies, some supposing it to answer to the second valve of bivalves, and the opercular mantle as correspondent with one moiety of the mantle of the bivalve, while others regard the operculum as homologous with the byssus. Dr. Mörch reviews these opinions in the 'Annals,' and traces the cleft of the mantle in some univalves, as in the dentated furrow of *Monoceros*, *Ancillaria*, *Pseudoliva*, and chiefly in *Carinaria*, in which genus the keel is formed by the two sides of the shell, which are pressed against each other in such a manner that a piece of paper can be introduced into the middle of the keel as far as the fœtal shell. The shell of the young Dentalium is also split throughout its whole length. Also in the Acephala nearly all the organs are double; there are two ovaria with distinct orifices, two kidneys, two pairs of labial palpi, two pairs of gills. It seems therefore probable that the Acephala have also two shells originating in the same way. This duplicity is very indistinct in the univalves, and becomes rarer and rarer in the higher mollusca. The larva of *Anodonta* has in each shell a distinct byssus bundle, and a distinct intestinal channel with distinct oral orifices. Does the opercular lobe then, with its operculum, represent one lobe of the mantle and its shell in the bivalves, or is it something else? The fact of the operculum co-existing with the byssus in the same univalve, which sometimes happens, proves that Lovén's opinion that the operculum is homologous with the byssus cannot be correct. It must be also remembered that it is not known how the byssus of univalves is formed. The *float* of Ianthina which attaches the animal to the surface of the water is probably homologous with the byssus, judging from its ventral position. In Acephala it is generally corneous, but in *Anomiæ* it forms a calcareous plate (the plug), possibly corresponding with the opercular valve in Hipponyx, which may be considered as a calcareous secretion of the ventral face of the foot. The epiphragm of the Helices would also be homologous, if this plate be really a secretion of the foot, but it is probably secreted by the mantle like the septa of Vermeti. It appears that all parts of the skin in Mollusca can secrete a shell. In the Bullidæ and some Pellibranchs there are thick calcareous plates in the stomach.

As supplementary to the remarks lately made upon the special hairs of Crustacea, it may be added that MM. Claus and Sars have independently investigated the Schizopods of the family Euphausidæ with regard to the organs alluded to by Dana, Semper, and Kroyer, and regarded by Semper as eyes and by Kroyer as auditory organs. They are spherical bodies of a reddish colour, situated at the base of several of the thoracic legs and at the first four pairs of abdominal appendages. Both of the authors above mentioned have demonstrated the correctness of Semper's view, although besides these pedal eyes, the animals possess the two large compound eyes common to all Decapods. Each of the thoracic and abdominal eyes receives a special nerve from the ventral ganglionic chain. The organ itself is a spherical bulb moved by special muscles, and in it may be distinguished a crystalline lens, a vitreous body, a pigment layer, and a retina of complex structure. The existence of a crystalline lens distinct from the cornea is very striking, for in other Crustacea no true crystalline lens exists, its function being performed by the thickened and inflated cornea. According to M. Claus the position of the four pairs of abdominal eyes is very remarkable: the first pair looks forward, the last pair backwards, and the two intermediate pairs downwards.

Dr. McIntosh describes the internal parasites of *Carcinas Mænas*, or the common shore-crab, consisting of a trematode larva and Ascaris. He found adhering to the sheaths of the nerves from the great thoracic ganglion, minute specks in groups of two and three. The same bodies were found in the liver, and proved to be small glassy ova with opaque white internal markings. They were found in every specimen examined, and in well marked cases they occurred in hundreds, crowded together like clusters of grapes. The egg case was very tough and contained a living embryo which has a gentle gliding movement in the egg. It lies in a double or coiled position, and after extension crawls about with an undulating motion like a Planaria. At the upper end is a circular oval sucker, from which an œsophagus proceeds downwards dilating into an ovoid sac, and again contracting, passes down the middle of the body, and finally divides into two wide alimentary cæca, forking outward to the sides of the body. These ova, which occur in nearly every soft texture in the interior, except perhaps the heart, appeared to be nearly of the same age in every specimen; in all probability they attain little more development in the body of the crab, but await the ingestion and digestion of the Crustacea by such fishes as the Cotti, Gadi, and others, in whose stomachs they become complete Distomas. In two cases also an Ascaris was found amongst masses of liver removed from a Carcinus, and possibly swallowed with fragments of a fish.

Mr. Gosse describes in the 'Annals of Natural History' a new genus of Sea Anemones, which he says might well put in a claim to be considered Pulcherrima, if we had but a Paris to judge. The animal, which he has named Ægeon Alfordi, was discovered by the Rev. D. P. Alford, Chaplain of the Scilly Isles, in March last, under a large stone, from under which the tentacles were protruding like those of an Anthea. But on removing the stone he found an Anemone with high standing column, like an Aiptasia, but with the surface warted, and with tentacles like the richest green velvet, throwing into the shade the brightest of Antheas. This species Mr. Gosse finds to possess very obvious affinities to both Aiptasia and Anthea, but the character of the column distinguishes it well from either, and he has constituted for it the new genus, Ægeon. After very many protracted watchings with a powerful lens, when the body was in the most favourable condition for observation, he could never discern the slightest trace of *cinclides;* nor has any amount of provocation produced the emission of *acontia*. At present this is a unique specimen, but it is hoped others may be found. The Scilly Islands appear to abound with Aiptasiæ—other species and varieties are well represented—but among the rocks of Port Crassa Bay the Aiptasiæ are far more common than the Actinia mesembryanthemum.

Professor Bell communicates to the 'Zoologist' an account of a very severe injury done by a *Physalis*, or Portuguese Man-of-war, at

St. Vincent. A person bathing was seized by the long arms of this Acaleph, which wound its twining thongs completely round his body and instantly benumbed him. He would have been drowned had not a companion with him pulled him out of the water: but it was some hours before any hope was entertained of his recovery; his flesh was then twitching frightfully, and his body covered with wheals the size of one's finger, as if he had been beaten with thick cords.

X. SCIENCE IN BRAZIL.

In the Chronicle of Zoology of the last number of this Journal, we announced that Professor Agassiz and a party had left New York on the way to South America, on an exploring expedition, his chief object being to make extensive collections in zoology, and observations in other natural sciences. The expenses of the expedition are, as we stated, defrayed by Mr. Thayer, a liberal citizen of Boston.

Professor Agassiz arrived at Rio Janeiro, and leaving behind him a memento of his presence, has passed onwards to the Amazons. His progress so far has been chronicled by an excellent little journal called 'The Anglo-Brazilian Times,' and a copy of that journal (dated July 8th) having been forwarded to us, we extract from it for the perusal of our readers the following interesting account of services rendered to science by Professor Agassiz during his sojourn in Rio:—

"In the midst of so much of the conflicting elements of war, with the news of victory scarcely subsiding into calm before other reports of defeat and disaster come to distress the public mind, and to kindle, let us hope, in all hearts a yet stronger spirit of national enthusiasm, we as journalists have to note that, side by side, the desolation of war is accompanied by the peaceful spirit of scientific investigation. Professor Agassiz has for a time suspended his operations in this part of the empire, and is going with his staff to explore the district watered by the Amazon.

"Our readers will be aware that since the illustrious stranger arrived in Rio he has not been for a moment at rest. Whilst his assistants have been each in his special department working towards the attainment of the object which they have in view in Tropical America, the Professor himself has been the most active of the party, trying to win from nature the secrets which she holds, and we are informed that many new and interesting facts have been added to the domain of science. Apart from the collection of these facts, and from expeditions in and about the Province of Rio de Janeiro, the Professor has given us opportunities of hearing him explain his theory of erratic boulders, and all who have heard him have been struck with the ease by which the dry bones of a scientific fact can be made replete with interest when handled with simple grace by a clear and comprehensive intellect. The illustrious teacher is, as we have said, going for a time from the capital, let us be assured only to return to it laden with treasures which will, under his powerful exposition, teem with interest for scientific men in all quarters of the globe, and which for the country we are in will have a very direct and special importance.

"We have from the outset looked upon this expedition with great interest, in so far as we have seen in it a value lying without the fields of pure science. The speculations of the philosopher of to-day may to-morrow become the established facts of commerce, and it will be impossible for the investigations of Agassiz to leave behind them only barren results. His labours may in the end yield us a harvest of material wealth; indeed, we have before us at this moment one very pertinent illustration of this fact, which we may assume is but the forerunner of many others of a kindred kind.

"Our readers have for a long time heard of the famous coal beds of Candiota, in the Province of Rio Grande do Sul. The expectations of many are turned in that direction, as the most valued instance of the hidden wealth of Brazil. Mr. Plant has so far awakened or revived an interest in these things that from time to time the topic has been made a public one, has been looked at as a field for commercial activity, and has been debated each time with growing interest in the legislature. We are not to-day talking of the value of this matter in the abstract, our minds have long been made up upon that question; we only wish to show how the opinion of a man like Agassiz at once settles the whole question, and leaves only to commerce the practical development of plans for making available this most important element in a nation's wealth and power.

"Mr. Plant, as a geologist, submitted to the examination of the Professor such fossils and geological illustrations of the Province of Rio Grande do Sul as he supposed would be of interest, and would help to complete the collections which are being made for the United States Government. The importance of these fossils and the sure deductions which science draws from them appear to have startled and delighted the great *savant;* and a few days since the following letter was placed in the hands of Mr. Plant. We print it *verbatim*, as it is of such a nature as to become at once important, and will show the Government of Brazil that if it only follows up the path opened up by science the results as a source of wealth cannot be doubted.

"'*Rio, June* 18, 1865.

"'Dear Sir,—I have not yet returned my thanks for the fine specimens you have presented to me, though ever since I saw them I have looked for a moment's leisure to do so.

"'However, this gives me an opportunity of expressing a more mature opinion concerning their geological age, which I am glad to have an opportunity of recording, especially since the examination I have made of them has satisfied me of the correctness of some views concerning the fossils of the oldest geological formation, in which I had little confidence. That these organic remains all belong to the carboniferous period is unquestionable, and it is the close affinity with the characteristic fossils of Europe which particularly interests, and in a measure surprises me. Had the whole collection been made in Pennsylvania, I would not more decidedly have recognized its carboniferous characteristics, down to the rocks underlying and overlying the fossiliferous beds; and the photographs you have shown me of the localities leave no doubt of the great extent and value of the coal-beds proper of the river Candiota, whilst the coal itself may fairly be compared to the best in the market, judging from the specimens you have shown me, and those I owe to your kindness.

"'As to the coal of the Falkland Islands, I can only compare it to the Anthracite of Mansfield in Massachusetts, and the adjoining deposits in Rhode Island; though it does not appear quite so pure as the best Anthracite of the United States; but this is an impression derived from surface specimens, gathered at random.

"'With my best wishes for the further success of your geological explorations, in which I hope you may hereafter also include the drift and erratics, now that you are satisfied of their existence in Brazil,

"'I remain yours very truly,

"'L. Agassiz.

"'*N. Plant, Esq.*'

"We think our subscribers will join with us in our opinion that we have much to look for from this expedition fitted out by the munificence of a Boston merchant. It may be that with a conviction of the value of science as an agent in commerce this expedition has been projected. We are sure the indirect results will, for Brazil, be very important. One of the world's greatest *savans* is breaking in upon a region almost unknown. His aim is, we know, to extend the empire of mind and to storm the strongholds of nature, making her subservient to the wants of man, and in parting with Professor Agassiz and his co-labourers for a season, we can but give him our benediction with the hope that in a few months he will be amongst us again rich with treasures from the Amazon, and that before he leaves Brazil for his adopted home he may be able to delight us with a course of lectures specially illustrative of his investigations in the land of the Southern Cross, and of the treasures which are lying waiting to be made useful by the energy of man.

"(1) We point to the latter portion of this very important letter of Professor Agassiz as a provisional answer to the assertion made by the medical officer of H. M. S. Stromboli 'to the effect that coal does not exist on the Falkland Islands.' The question is a scientific one, and the Great Philosopher from Cambridge, U.S., has by geological deduction, as we have seen, declared in favour of the position assumed by Mr. Ramsay Cooke, of H. M. S. 'Egmont,' who was the first discoverer of these coal-beds, and who assures us that the coal from these deposits was burned by H. M. S. 'Satellite,' on her passage from the Falkland Islands to Rio.

"(2) We are also at liberty to state, that Sr. Capanema, whose abilities as a geologist are too well known to need comment, has also seen Mr. Plant's collection of fossils from the Candiota coal-mines, and has arrived at the same conclusion as Professor Agassiz in respect to the coal-beds belonging to the carboniferous period, a fact which the illustrious Sr. Capanema had hitherto doubted."

XI. SCIENCE TEACHERS' ASSOCIATION.

In an article on "The Science and Art Department" in the January number of this Journal, a suggestion was made that the teachers of Government Science Classes should form themselves into an association for the protection of their mutual interests. We are glad to find that it has had the effect of leading to the formation of a union. Meetings of Science teachers were held in Birmingham on the 8th and 12th of September (during the Meeting of the British Association), for the purpose of considering the question. The feeling in favour of forming a united body was shown to be very general; a considerable number of teachers who could not be present expressing their concurrence by letter, generally in very warm terms. At the meetings referred to it was resolved to form a body, to be called 'The Association of Certificated Science Teachers,' and to be open to all those teachers who are certificated in Science by the Department of Science and Art. Its objects were defined to be the furtherance of Science instruction in connection with the system of the Department of Science and Art, the advancement of Science teaching as a profession, and the mutual interchange of ideas and information. The business of the Association will be conducted by a Council, consisting of a President, a Secretary, a

Treasurer, and nine other members, to be elected annually. The President, Secretary, and Treasurer constitute a Sub-committee for the consideration of all communications addressed to them by members on matters connected with the objects of the Association: and, when necessary, the subject of any such communications will be referred to the Council or to the general body of members for further action. In this way, each Science teacher will have the opportunity of bringing under notice any information, suggestion, or difficulty; and whenever the importance of the case demands, the Council will proceed to ascertain the opinion of the whole body of teachers thereon, or to recommend joint action if necessary. A subscription of five shillings per annum is expected to cover all expenses, and at the same time to be not more than will be readily subscribed by Science teachers. A general meeting is to be held annually in the month of July, in some town conveniently situated; at which meeting the reports of the Secretary and Treasurer will be received, the officers elected, and all business transacted and subjects discussed which have been considered and approved by the Council. Members wishing to bring forward matters for discussion must give due notice to the Secretary. It is considered that by these arrangements all suggestions will receive due consideration, whilst all subjects of general interest will be brought before the whole body of teachers.

At the meeting of the 12th September, a code of rules embodying the above points was considered and adopted. The Council for the ensuing year was elected; Dr. E. H. Birkenhead, of the Wigan Mining School, being appointed president; Mr. John Jones, of Dudley, treasurer; and Mr. John Mayer, of Glasgow, secretary. It was decided to hold the first annual meeting at Liverpool, in July next.

REVIEWS.

RADIATION.*

A NOT very enlightened sceptic once remarked that he doubted "whether there was any other God but motion." Had he not ignorantly mistaken effect for cause, and if he had, instead, uttered a doubt whether there was any physical *force* other than motion, he would have been nearer the truth, and would have expressed the view of the most advanced thinkers of our time. For every day it is becoming more apparent that the various forces or phenomena known to us as Heat, Light, Electricity, &c., all result from the more or less rapid motion of matter in a more or less attenuated form. Thus, when we hear of light travelling at the rate of 192,000 miles per second, reaching our earth in about eight minutes after it has left the sun, we are not to suppose that any special force is being employed, differing from that which conveys the sensation of heat from a body of elevated temperature to our persons, or from that which causes the air, agitated by the vibrations of a sonorous substance, to strike against the tympanic membrane of the ear, and produce the impression of sound. All these manifestations, light, heat, and sound, are believed to be simply the effects of the more or less rapid vibrations of atoms of matter variously grouped, communicated to organs of the body differently constituted to receive those divers impressions.

When any hard substance is submitted to violent friction, heat, sound, and perhaps electricity, may be the result of the motion of its molecules. In the case of sound being produced, the atoms of the resonant substance first begin to vibrate, then they impart motion to the molecules of the circumambient air, and this being agitated in waves reaches the tympanic membrane, and there produces the effect which we know as "sound," an effect which is passed onwards through the complicated structure of the ear and the auditory nerve to the brain, whereby the mind is rendered conscious of its existence. A similar motion of particles, conveyed with or without the medium of the air, to the nerves of touch, causes the phenomenon of heat, which may be communicated to the brain and be thus rendered conscious, or it may be arrested at the surface of the body, and affect only the muscular system by what is called "reflex action." But should the friction of the hard substance be sufficiently protracted and violent, or if the substance itself be peculiarly susceptible (as in the case of phosphorus), a third effect follows upon the production of heat, namely luminosity, or the emission or radiation of light. This effect of the motion of matter is conveyed to the optic nerve, and thence to the brain, even where no atmosphere intervenes, and the medium of communication is believed to be the "luminiferous æther" which is supposed to pervade all space.*

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* 'On Radiation.' The Rede Lecture delivered in the Senate House, before the University of Cambridge, on Tuesday, May 16th, 1865. By John Tyndall, F.R.S., Professor of Natural Philosophy in the Royal Institution, and in the Royal School of Mines. London: Longmans.

'The Phenomena of Radiation, as Exemplifying the Wisdom and Beneficence of God.' (Actonian Prize Essay.) By George Warington, F.C.S. London: William Skeffington.

'Heat Considered as a Mode of Motion.' By John Tyndall, F.R.S., &c. Second Edition, with Additions and Illustrations. London: Longmans.

Thus it will be observed that the friction of some particular form of matter may give rise to what are regarded as three distinct phenomena—sound, heat, and light; the first being sound, then, as the vibration of its atoms become more rapid, heat, and finally, when the temperature has been sufficiently raised, light is the result.† But this may be merely an outline of the successive phenomena arising from simple application of mechanical force to matter and the vibration of its atoms. In the case of sound, the tone emitted may rise in intensity, changing its quality as the vibrations become more rapid, and the effect of a musical scale may be produced; and in like manner the rays of light emitted may, as the radiation becomes more rapid, not only change their character to the appreciable sense, rising in the scale of colour, to use a familiar expression, and perhaps producing what to some organs of vision differing from ours, may form parts of a chromatic or colour scale divisible into octaves,‡ but they may even act as distinct forces, some with chemical effect, others with illuminating, and others again with thermic influences. Let us now, instead of considering the phenomena attendant upon the heating of a substance by friction, select an example, where the heat is the result of electricity, and we shall be enabled to obtain a very clear picture of the effects just named.

"If a current of electricity of gradually increasing strength be sent through a wire of the refractory metal platinum, the wire first becomes sensibly warm to the touch; for a time its heat augments, still, however, remaining obscure; at length we can no longer touch the metal with impunity, and at a certain definite temperature it emits a feeble red light. As the current augments in power, the light augments in brilliancy, until finally the wire appears of a dazzling white. The light which it now emits is similar to that of the sun."§

And if the light thus emitted be analyzed by means of a prism, as it increases in brilliancy it is found "that when the platinum wire first begins to glow the light emitted is a pure red. As the glow augments the red becomes more brilliant, but at the same time orange rays are added to the emission. Augmenting the temperature still further, yellow rays appear beside the orange, after the yellow, green rays are emitted, and after the green come in succession blue, indigo, and violet rays. To display all these colours at the same time the platinum wire must be *white hot*, the impression of whiteness being in fact produced by the simultaneous action of all these colours on the optic nerve."*

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* 'Radiation' (Tyndall), p. 18.

† In the case of glass or sealing-wax, we have sound, heat, and magnetism or electricity.

‡ See note on the "Probable Existence of the Repetition of Octaves in the Solar Spectrum," by C. Hilton Fagge, M.D., 'Quarterly Journal of Science,' No. v., p. 182.

§ 'Radiation' (Tyndall), pp. 2, 3.

It has already been stated, and is no doubt well known to our readers, that these variously-coloured rays possess different properties, thus, the undulations which reach the eye, as orange or red rays, possess specially a heating property, the yellow, an illuminating power, and the blue or violet an actinic or chemical influence, and in the white or colourless light of the sun we have these three properties perfectly combined, for the complete fulfilment of the ends of nature. If, then, we glance hastily over the whole series of phenomena of radiation, we find that physically they take their origin in the motion of matter. Whilst the nature of the substances, or form of matter acted upon, is diversified in the extreme, the force in operation, or the mode of motion seems to be uniform; at least it appears to vary only in the speed with which the atoms or molecules are agitated. But the results, as conveyed through the organs of sense to the brain, are incalculably diversified; sounds which charm the ear or soothe the soul; others that fill the mind with terror; various degrees of heat, from the gentle warmth of the morning sun, to the glowing metal from the furnace; and light of all hues and tints, direct and colourless, or partially resolved into its original elements, by reflection from the pansy or the rose, or from the verdant carpet of the pastures; each affects with its power to minister to life or modify the character of nature's forms or forces.

The ascription of these phenomena to so simple a cause as the motion of matter, known as radiation, is not the result of speculation only; for much is already known concerning the rapidity with which the atmosphere and the presumed luminiferous æther (or whatever may be the medium through which light is transmitted) are set in motion. It is well established that a sonorous wave moves at the rate of 1,100 feet per second, or rather that the impression of sound is conveyed to the ear at that rate; also, that a ray of colourless light is projected through the ether, at the speed of 192,000 miles in a second; that if such a ray be resolved into its constituent elements as exhibited by the prism, red light travels more slowly than orange, orange than yellow, and so on to the violet, whilst at either end of the spectrum there are "non-luminous rays" which move either too slowly or too rapidly to produce any effect upon the human retina.

These non-luminous rays although invisible to us have still very marked properties; those beyond the red end of the spectrum possessing great heating power, whilst those at the other extreme are endowed with considerable actinic properties; indeed Dr. Tyndall has shown that as far as the electric light is concerned by far its greater heating power is exercised at a considerable distance beyond the red, or thermal end of its spectrum.* When we add that it is even estimated, in round numbers, at what rate each of these rays is projected,† it is not unreasonable to believe that the chief, if not the sole cause of the varied phenomena, known to us as light, heat, &c., are all varieties of the same force; namely, the simple motion or radiation of matter, and it remains for physicists to pursue their inquiries into the behaviour of various forms of matter in an uncombined or combined state.

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* 'Loc. Cit.', p. 3 (Dr. Draper's experiment).

In this department of research, also, much has been effected, and Dr. Tyndall's work on "Heat Considered as a Mode of Motion," comprises an admirable *résumé* of almost everything that is known on the subject. It treats of the deportment of the various gases, liquids and vapours, of the metals, woods, simple bodies such as iodine, bromine, &c., and of the effect of radiation upon compound substances, as lamp-black, &c.; and describes many novel and original experiments bearing on the subject. His second work on "Radiation," however, brief though it be, possesses far greater interest for scientific men, for it deals largely with the question of radiation in "æther," air, vapours, perfumes, &c.; and reveals many startling novelties concerning the influence of matter in a diffused form upon the passage of heat. Let us extract a single series of experiments:—

"*Absorption of radiant heat by vapours and odours.* We commenced the demonstrations brought forward in this lecture by experiments on permanent gases, and we have now to turn our attention to the vapours of volatile liquids. Here, as in the case of the gases, vast differences have been proved to exist between various kinds of molecules, as regards their power of intercepting the calorific waves. While some vapours allow the waves a comparatively free passage, in other cases the minutest bubble of vapours, introduced into the tube already employed for gases, causes a deflection of the magnetic needle.‡ Assuming the absorption effected by air at a pressure of one atmosphere to be unity, the following are the absorptions effected by a series of vapours at a pressure of $\frac{1}{60}$th of an atmosphere:—

Name of vapour.	Absorption.
Bisulphide of carbon	47
Iodide of methyl	115
Benzol	136
Amylene	321
Sulphuric ether	440
Formic ether	548
Acetic ether	612

"Bisulphide of carbon is the most transparent vapour in this list; and acetic ether the most opaque; $\frac{1}{60}$ of an atmosphere of the former, however, produces 47 times the effect of a whole atmosphere of air, while $\frac{1}{60}$ of an atmosphere of the latter produces 612 times the effect of a whole atmosphere of air. Reducing dry air to the pressure of the acetic ether here employed, and comparing them then together, the quantity of wave motion intercepted by the latter would be many thousand times that intercepted by the air.

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* Tyndall, pp. 23 and 24, and Frontispiece.

† The extreme red rays making 474,000,000,000,000 vibrations in a second, and the extreme violet 699,000,000,000,000.

‡ The "tube" and "magnetic needle," here mentioned, are instruments which will be found described in "Heat considered as a mode of motion."

"Any one of these vapours discharged in the free atmosphere in front of a body emitting obscure rays, intercepts more or less of the radiation. A similar effect is produced by perfumes diffused in the air, though their attenuation is known to be almost infinite. Carrying, for example, a current of dry air over bibulous paper moistened by patchouli, the scent taken up by the current absorbs thirty times the quantity of heat intercepted by the air which carries it, and yet patchouli acts more feebly on radiant heat than any other perfume yet examined. Here follow the results obtained with various essential oils, the odour in each case being carried by a current of dry air into the tube already employed for gases and vapours:—

Name of Perfume.	Absorption.
Patchouli	30
Sandalwood	32
Geranium	33
Oil of cloves	34
Otto of roses	37
Bergamot	44
Neroli	47
Lavender	60
Lemon	65
Portugal	67
Thyme	68
Rosemary	74
Oil of laurel	80
Camomile flowers	87
Cassia	109
Spikenard	355
Aniseed	372

Thus the absorption by a tube full of dry air being 1, that of the odour of patchouli diffused in it is 30; that of lavender 60, that of rosemary 74, whilst that of aniseed amounts to 372. It would be idle to speculate on the quantities of matter concerned in these actions."

It would be impossible, in a short notice such as the present, to refer to the numerous and interesting results that have been obtained by experimenting upon the passage of heat through the atmosphere, or *in vacuo*. Dr. Tyndall has tested the absorbing and analyzing powers of numerous substances, and in some cases has applied his experiments to practical ends, or at least he has indicated channels in which they may be practically employed. Thus he has tested, physically and chemically, the percentage of carbonic acid in the human breath, and when we remember what startling and unexpected results have recently been obtained by means of spectrum-analysis; how, for example, blood has been traced in fabrics long after the tell-tale fluid was spilt upon them, we cannot but watch with interest, researches which have a direct bearing upon physiological and sanitary science.

But there are even higher and more important benefits likely to accrue to the human race from such scientific studies as these, however valuable they may be in a material sense. The information which is pouring in upon us day by day concerning the subtle forces of nature and the properties of matter tends to develop the intellect, to exercise the reasoning faculties, and to substitute for unreasoning credulity and superstition a rational and ever-expanding conception of the Creator.

It is to the task of thus interpreting the recent revelations of Science that Mr. Warington has applied himself; and most deservedly has his noble work been rewarded by the bestowal of the Actonian Prize; a premium which the goodness of a lady has bequeathed for the encouragement of a reverential study of Science. With this view the author has not contented himself with treating of the phenomena of radiation only in as far as they are to be observed in the inorganic world, but he has shown how admirably the laws of motion here referred to were framed for the advent of organized beings.

Although the discussion of vital forces can hardly be considered to come within the scope of the subject treated, yet we can easily conceive that in his reflections upon the influence of radiation the author would be drawn into those indirect results, or rather accompaniments, of the operation of physical forces, and it would be almost as anomalous to overlook the presence of plants and animals, in their relation to heat, light, &c., as it would be to give the geography of a country and omit to make mention of its inhabitants. Thus he does not confine his observations to the method in which the forces operate, nor limit his field of inquiry to the inorganic world; but he shows how all these, the meteorological, geological, and astronomical changes bear upon the life of plants and animals. Nor does he for a moment appear to lose sight of the main object of his essay. Whilst it is free from anything like cant, and presents no approach to that spirit of intolerance which would dictate to the students of science in what theological Shibboleth they must seek their axioms, it is one fresh, joyous pæan of praise to the Creator, expressed, as far as man is able to do so, in suitable poetical language.

In every dewdrop, in every cloud, in each ray of sunshine, in every gentle gale that blows, he sees, and sees rightly, a fresh evidence of the "wisdom and beneficence of God." But we will let him speak for himself, selecting a somewhat lengthy extract from his work to show how ably it is penned:—

"But yet, again, the *kind* of radiant force the sun gives forth is beautifully accordant with the work it has to do. The mighty operations of its beams that have engaged our attention hitherto are all accomplished by *one* section only of the rays composing them—the heating rays: almost wholly by those invisible to the eye, the extra-red. Some few of the more highly refrangible rays are changed, indeed, by absorption, and so become effective; but the proportion done by these is scarcely worth notice. It is to the originally obscure heat rays of the solar spectrum that winds and rains and currents owe their origin. These rays, as before noticed, are those which lower temperature occasions, merely rising in intensity and number with the development of quicker undulations. They are hence just those which of necessity must be most numerous and powerful in such a mixed radiation as the sun's. Had the case been otherwise—had we depended exclusively upon the visible solar rays for climate—had these been heating and those luminous—our earth would have been in sorry plight; they have not intensity of power equal to such needs. Yet can Science tell us why such minute differences in the length of waves of motion should confer such different powers? She can but say they do. And as their doing so is manifestly necessary to the maintenance of Nature's order, the fulfilment of her ends—plainly, too, adjusted to the properties and forms of matter they affect—Religion claims them for her own, and says God made them so.

"Standing at this height, then, and regarding every part of this vast system of causes and conditions as coming straight from God, how marvellous a picture of His mind and attributes does it present. Before yet any force or matter existed, He was planning out their nature and relationships, determining the absolute quantity and form of each, bestowing properties and powers, ordaining laws, parting each several kind to its predestined place and office, allotting to each its own peculiar work, yet causing all to aid and help the others; disposing with like ease and skill the mightiest and minutest agents, the causes and conditions of each varied action; adjusting link to link in complex order, each influencing and modifying the rest, yet all together subserving one great purpose, and so subserving it as if it were their purpose too, as if they too desired their Creator's ends; watching and guiding all from age to age, developing and perfecting the scheme by gradual elaboration, until at last it reached its present form and symmetry, its beauty of proportion, its meetness for its end. Such wondrous harmony in Nature's working, such seeming will and purpose, might almost make one think there was a life, a mind, in things inanimate. Yet no; these are but the robes, the outward dress of Deity, bearing the impress of their Maker truly, but of themselves incapable of aught; they are but instruments to work His will—perfect instruments, because made and adapted for that very end, and wielded by the All-wise hand that made them—yet still but instruments. Man compares his instruments and machines with this, and how immeasurably inferior now do they appear; how crude, how clumsy. How vast—how infinitely vast—the distance that separates the Creator's mind and wisdom from the man's!"

Besides its higher merit, Mr. Warington's little work possesses that of being educational, for it comprises a popular *résumé* of all that is generally known in regard to the operation of the physical forces in nature; and it is a book which we would especially recommend to teachers of youth, inasmuch as it is calculated to impress the latter with the value of such knowledge more effectively than a mere handbook of physics.

There are some expressions in it which we have either not clearly understood, or they are at variance with the general views enunciated by the author. Are we to understand that the "sun's surface particles" are themselves "shot hither through thirty million leagues of fine intangible æther," or merely that their "delicate tremor"[*] in the sun's surface is communicated to our atmosphere through the wavelike agitation of the "fine and intangible æther diffused throughout all space and throughout all matter?"[†]

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[*] P. 102.

[†] P. 24.

It appears to us that these two cases precisely represent the difference between the exploded view that heat is matter, and the one which regards it as the mode in which matter is moved; either the author is wrong in his science, or there is a want of clearness in his diction which we have noticed elsewhere in the work.

This does not, however, detract in any material degree from the merit of a beautiful and edifying scientific essay, to which, as well as to Dr. Tyndall's treatise, we desire to accord all honour and praise.

THE SCENERY OF SCOTLAND.*

With the exception of Scandinavia, there is no country in Northern Europe whose physical features more boldly challenge the investigation of students of nature than Scotland. Geographers, whose province often extends only to the outline and surface, have never failed to point out the striking contrast of its eastern and western shores, attributing the more deeply indented margin of the latter to the fierce assaults it has experienced from the Atlantic breakers, forgetting, however, that many of its deepest bays and fiords stretch inland at right angles to the direction of the waves, and can, therefore, in no way be attributable to their action. Nor has the surface of the country attracted less attention than its outline. The stern and wild region of the Highlands, divided by the deep channel of the Caledonian Canal; the lofty rampart of the Grampians ranging from sea to sea across the island, and forming the physical boundary of the Lowlands; the broad undulating valley of central Scotland, stretching southwards from the base of the Grampians, and deeply indented on both sides by the Firths of Clyde and Forth, and bounded on the south by "The Southern Uplands," as they are termed by the author, —a region of high swelling moorlands and narrow valleys, neither so lofty nor bold as the Highlands, yet attaining in Merrick an elevation of 2,764 feet.

Mr. Geikie enters upon the task of expounding the physical changes which have resulted in the scenery of Scotland with all the enthusiastic love and admiration which every Scot bears his native land, and to which Scotland's great poet gave such memorable expression—

> "Land of my Sires! What mortal hand
> Can ere dissolve the filial band
> That knits me to thy rugged strand?"

while he is at the same time thoroughly imbued with the more "advanced" theories on the subject of atmospheric denudation and glacial erosion. The author is also a warm supporter of Professor Ramsay's theory of the glacial origin of lakes, and, with many of the younger geologists, he maintains the sufficiency of frost, snow, and ice, rains, torrents, and rivers, to channel out the valleys of mountainous regions. "Only give me time," he says, in so many words, "and I can remove mountains." Nor is it necessary to remind our readers that the geologist takes as much time as he pleases whether it is given to him or not.

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* 'The Scenery of Scotland, viewed in connection with its Physical Geology.' By Archibald Geikie, F.R.S. Macmillan & Co.

The earlier pages of Mr. Geikie's work contain an interesting account of the rapid waste which the eastern coast of Scotland has undergone within historic times. Along some parts this waste is alarmingly rapid. Villages, churches, castles, farms, of whose former existence there is historic record, have disappeared before the ceaseless attacks of the waves, so that, contrary to the popular notion, this coast is wearing away with much greater rapidity than the western. The process of decay is also facilitated by the generally softer nature of the rocks on the eastern coast, a considerable length of which is formed of Old Red Sandstone. On the western side, the parts which are most frequently exposed to the attacks of the Atlantic breakers, are composed of tough gneissose or slaty rocks, admirably adapted for resisting disintegration, while the long chain of the Hebrides, stretching athwart the coast, acts in some degree as a natural breakwater to the mainland.

Mr. Geikie divides the surface of the country into three physically distinct regions—the Highlands, the Central Valley, and the Southern Uplands—each of which he treats of separately. He considers that about the commencement of the period of the Old Red Sandstone the highlands began to appear from below the sea in the form of an undulating plain with occasional prominences. This was "a plain of marine denudation." Thus far the author only recapitulates the views of Murchison, Sedgwick, Nicol, and other geologists. But now arises the question, How, out of such a plain, were the mountains and valleys formed? Was it by the upheaval of some special lines and the depression of others, assisted by the action of the waves and currents as the land continued to rise above the level of the sea? Or, on the other hand, has the result been brought about by atmospheric agencies? Now, while admitting that the occasional displacements of the strata by faults, and minor elevations and subsidences, may have had some slight effect in originating lines of hill and valley, and also that the sea had its due influence, the author regards the atmospheric agencies as by far the most powerful. To the former view there is this serious objection—that the action of the sea tends invariably to level all opposing barriers, and to reduce the surface to one nearly uniform plain. Nor is it conceivable that the sea could produce valleys of the kind which occur in the Western Highlands, or the firths and sea-lochs which pierce the coast all along its margin from Cape Wrath to the Clyde. A glance at a well-shaded map (such as that which accompanies this volume) will serve to show that the sea-lochs are generally continuous with the valleys or glens of the land, and that they are to be considered only in the light of submerged valleys. In proof of this Mr. Geikie adduces what to our mind seems conclusive evidence in the fact, that they contain in some places "rock-basins."

In seeking, then, for a cause sufficient to account for the scenery of glaciers which once overspread the whole of the lower grounds, as in Greenland at the present day; the newer which shows rude traces of the Highlands, we are forced to leave the ocean and take to the land; and here we see agencies actually in operation, either in this or other lands, which in the author's opinion are fully calculated to produce, when acting throughout incalculable ages, that striking variety of mountain and fell, glen and loch, which, when once seen, leaves an impress on the mind never to be effaced.

Let us now follow the author in his view of the manner in which all this has been brought about.

Starting with the assumption that the Highlands were raised from the ocean in the form of a plain or table-land, with a few points or lines slightly outstepping the surrounding areas, he supposes that this plain would at once be subjected to atmospheric influences. Rain falling on its surface would form itself into rills, which, uniting into brooks, would then find their easiest way into the sea. A channel once formed, however shallow, would go on increasing in width and depth, and as the land continued to rise, and the action of frost, rain, and stream combined in the work of scooping out and carrying away solid matter, valleys would ultimately be formed, and if valleys, mountains; because mountains of the kind of those in Scotland, Wales, and Norway, may be looked upon with much probability as portions of ancient table-lands, out of which the valleys have been scooped.

We have thus given a short outline of the views of the author without going into details, which space forbids. For ourselves we are disposed to go a long way in support of them; though, perhaps, not to the extent of the author himself. That rivers, and even mountain torrents have the power of scooping out channels and valleys of considerable depth and width is unquestionable; but where the valleys are wide, with very slightly shelving sides which bear no traces of river erosion, but on the other hand preserve the smooth and uniform contour which is presumably the effect of marine denudation, we are at a loss to conceive on what grounds atmospheric agency can be called in here. The case is also strengthened if we find marine stratified deposits of the Drift period occupying such flats, as is often the case. That these main valleys were formed before the Drift period may be perfectly true, but we base our argument in opposition to the view of progressive atmospheric waste in *such* instances, on the presence, after so long a period, of these marine deposits.

In truth, the term "valley" is unfortunately vague, as in many instances one main valley may include several minor ones, and while these latter may owe their origin to one class of agencies, the former may be due to another class. Thus, the greater may be of marine growth, the lesser of fluviatile. A considerable portion of Mr. Geikie's book is necessarily devoted to the description of the glacial phenomena of Scotland in relation to its aspect, and the origin of its lochs, lochans, and sea-lochs or fiords. In this field there have been many fellow-workers; amongst whom Chambers, Nicol, and Jamieson hold a prominent place. He considers that there are two very distinct kinds of boulder clay: the older being unstratified and due to bedding, having been deposited by the sea during a subsequent partial submergence. The rock-basins, both those now under the sea and inland, he unhesitatingly attributes to the scooping power of land ice, as well as the generally rounded form of the lesser hills, and those of the Southern Uplands of the Borders.

The work is accompanied by a very beautifully executed geological map of Scotland, published originally by the author conjointly with Sir R. Murchison, but embracing all improvements up to the present time; and we can only say in conclusion, that whether or not we agree in every point with the author, we have no hesitation in admitting the ability with which the subject is treated, and the rich store of observations on the physical geology of Scotland which the book contains.

SATURN AND ITS SYSTEM.*

When the peculiarity and beauty of the Saturnian system are considered, it cannot be surprising that it has attracted much attention and been the subject of many speculations. Even before the invention of the telescope it is probable that a peculiarity of configuration, due to the presence of the rings, had been recognized by the ancient astronomers, who surveyed the heavens from the elevated plains of Asia. For in a letter written some years ago to Sir J. Herschel, by the Rev. Mr. Stoddart, from those very plains (from Oroomiah, in Persia), the following suggestive passage occurs :—"It is not too much to say that, were it not for the interference of the moon, we should have seventy-five nights in the three summer months superior for purposes of observation to the very finest nights which favour the astronomer in the New World.† I was very curious to know whether any traces of Saturn's ring could be discovered. To my surprise and delight, the moment I fixed my eyes upon it steadily the elongation was very apparent. . . . Several of my associates, whose attention I have since called to the planet, at once told me in which direction the longer axis of the ring lay, and that too without any previous knowledge of its position or acquaintance with each other's opinion." The extraordinary clearness of the eastern atmosphere may perhaps serve to explain a curious statement in 'The Phenomena' of Aratus, written about 240 B.C., *viz.* that men say, and poets pretend, that one of the planets has passed away. Whence it seems probable that the people from whom the Greeks derived their astronomical system could distinguish one planet more than was discernible from Greece. This people, as we shall have occasion to point out further on, was most likely the Assyrian; and the fact quoted above from Mr. Stoddart renders it possible that they might have guessed at the true structure of the Saturnian system, and precludes the necessity of our resorting to the author's conjectures, that the rings in early times were of much larger size than at present, and therefore easier of detection, or that telescopes as powerful as Galileo's were then in use. If, however, the knowledge of this system ever did exist it must have been lost in the lapse of time, for in none of the ancient astronomical writings, so far as we know, is it alluded to. To mention only one: Hyginus, the general bent of whose studies and whose position as librarian at Mount Palatine must have made him accurately acquainted with the opinions of more ancient writers, is silent concerning it. In the 'Poeticon Astronomicon' the planet is briefly described as of great size, and of a yellow hue, and as being "similis ejus stellæ, quæ est in humero Orionis dextro."

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* 'Saturn and its System: containing Discussions of the Motions (real and apparent) and Telescopic Appearance of the Planet Saturn, its Satellites and Rings; the Nature of the Rings; the "great inequality" of Saturn and Jupiter; and the Habitability of Saturn. To which is appended Notes on Chaldæan Astronomy, La Place's Nebular Theory, and the Habitability of the Moon; a Series of Tables, with Explanatory Notes, and Explanations of Astronomical Terms.' By Richard A. Proctor, B.A., late Scholar of St. John's College, Cambridge, and King's College, London. London: Longman & Co.

† Mr. Stoddart was an American, and had observed in many parts of the world with efficient instruments of his own construction.

But though, like all other physical sciences, astronomy has been greatly progressing, and that especially during the past two centuries, yet it would be altogether unjust to think lightly of the results obtained by the old philosophers, because their most powerful instruments were their eyes, because they were ignorant of logarithms and fluxions, or because they supposed the stars to influence human destinies. Mr. Proctor has done well, therefore, we think, to carry us back in imagination to primitive times, and thence to lead us step by step over the ground trodden by the contemplative men of the East, until they attained to the loftiest and possibly the justest conceptions of the grandeur, extent, and beauty of the universe. In his own words, "the time thus spent would not be altogether wasted if we only learnt thence lessons of patience and watchfulness." The method of teaching astronomy by first discarding all the appliances and aids which modern ingenuity has devised, and directing the pupil's unaided gaze to the view presented by the sky on a starry night, is altogether a novel one, but is as useful as it is novel, and is, moreover, as natural as it is useful, for not one in a hundred, perhaps, enjoys the advantages of telescopic aid till long after he has begun to watch and reflect on the strangeness of the planets' apparent motions. Placing the reader, therefore, in the position of a Chaldæan observer, Mr. Proctor shows, in a style peculiarly clear, how, on the true system of the universe being known, from simple and easily ascertained data conclusions of the most important character are deducible. To begin with the discovery of the planet in question, a discovery the explanation of which, as well as of its apparent motion, and of very much more in the book, is "applicable, with suitable changes in matters of detail," to other members of the solar system, thus rendering the work, though professedly limited to the consideration of one planet only, a valuable treatise on general astronomy. An Eastern shepherd, gazing night after night through the clear depths of his matchless skies, has his attention for the first time attracted by a dull yellow star. He is probably possessed of a rough map of the stars, and on referring to it cannot satisfactorily determine that the one in question is indicated.

He therefore marks down its place, and again and again directs his gaze towards it, until before long he fancies that it does not occupy quite the same relative position as it did when he first noticed it. With a curiosity thus excited he patiently continues his examination, until at length, to his inexpressible joy, the wandering nature of the strange star becomes a matter of certainty. He then traces its apparent course along the zodiac and begins to reason on the data ascertained, and by a variety of simple processes, which even the unscientific reader cannot fail to follow and comprehend (especially as they are illustrated by admirably-executed diagrams and star maps), determines approximately its distance, velocity, and period. Our limits forbid anything like a detailed examination of these processes. We may say, however, that the entire mathematical treatment of the subject is unusually clear and forcible. So soon, however, as the author gets beyond the region of demonstration, he appears to us to lay aside his usual clear-sightedness, and often to see things as through a haze, his reasoning from evidence which is only probable appearing much less forcible than it is when that evidence is demonstrative.

Before, however, noticing any of those matters on which we are compelled to differ from the author, we must call attention to one feature of the work which in our opinion greatly enhances its value. In the second appendix are a number of important tables, in each of which two values are given for every element whose determination depends on the sun's distance. The first values, which are the ones usually given in astronomical works, are those deduced from the solar parallax 8″·5776 given by Encke. But more modern researches have tended to show that this is too small, and that consequently the sun's distance, which depends on it, as well as the distances of all bodies which are estimated in terms of the sun's distance, are too great. Since this was first pointed out by M. Hansen it has been confirmed by two entirely independent methods, *viz.* by M. Foucault's determination that the velocity of light has hitherto been overestimated, the true velocity making the sun's distance correspond with the suggested alteration, and by the determination as the result of a system of observation set on foot by Dr. Winnecke, Vice-Director of the Observatory at Pulkowa, that 15″, the received value of the horizontal parallax of Mars when in opposition, is too small by about $\frac{1}{27}$ part, thus giving a corrected value, from which likewise the old estimate of the sun's distance from the earth is shown to be too great by about the same quantity as by the other plans. With this newly suggested and highly probable estimate the second values in Mr. Proctor's tables correspond.

Though not mentioned in the title-page, some space is devoted to a rapid sketch of the progress of astronomy from very early to very recent times. Such a sketch, however interesting in itself, would, perhaps, have been hardly relevant, had not each great discovery as it is described been applied by the author to the illustration of some point with reference to Saturn. It is a curious circumstance, and one not noticed by Mr. Proctor, although in the shape of footnotes much curious general information is thrown in, that Copernicus, the originator of one of the greatest revolutions in modern science, a revolution too, directly opposed to the faith of the Catholic Church, should have been a most determined enemy of his fellow-countryman and contemporary reformer in another field, Luther, against whom he signed an edict issued in 1526. In the application of Kepler's third law to the case of Saturn, the language is very obscure. This is the more noticeable as obscurity is a rare fault throughout the work. Even when the reasoning seems inconclusive the statements are clear. At page 39, however, when inquiring into the relation between the numbers 9·53885, or Saturn's mean distance in terms of the mean distance of the earth, and 29·4566 or his period in terms of the earth's period, it is said "the first is less than the second, but the square of the first is plainly greater than the square of the second" (than the second ?) "We must therefore try higher powers of the second" (of the first ?) "Trying the next power, that is, the square of the second, we immediately find the relation we are seeking:—thus, the square of the first number is less than the square of the second, but the next power or cube is almost exactly equal to the square of the second."

In July, 1610, Galileo began to examine Saturn with his largest telescope, discovering as he thought that the planet was triform. Examinations thus initiated led eventually to the discovery of the three rings and eight satellites. As Mr. Proctor adopts as the basis for a new theory on the nature of the rings, the grounds advanced by M. Otto Struve, in 1851, in his work "Sur les Dimensions des Anneaux de Saturne," in support of the hypothesis that the rings are rapidly advancing towards, and will ere long be precipitated on to, the globe, we shall devote a short space to an examination of the validity of these premises. They are as follow:—Since the time of Huygens, the width of the ring system, as determined by proportional admeasurements, has been steadily increasing by the approach of its inner edge to the globe; the dark ring since November, 1850, the date of its discovery, has itself been observed to increase considerably in width. The breadth of the ring was found by Huygens to equal that of the space between it and the globe. Herschel, 107 years later, found the ratio between the width of the ring and the space to be as 5 : 4, while still later observers have found it to be yet greater. Do these admeasurements form a sufficiently sound basis on which to rear a novel hypothesis? We think not. Before stating our reasons for so thinking, we would remark a statement of the author's which seems in itself sufficient to throw doubt on its soundness. He says that Pound made the width of the system less than that of the dark space, but that he selects Huygens's measurements as less favourable to his case. But would Pound's measurements have favoured the case? If they had been made before Huygens's they might have been thought to do so, but the truth is that they were made after his, and therefore on the supposition that both are equally reliable, they should be taken to indicate a *diminution* in the breadth of the system between the two periods of measurement—an occurrence which would militate against that uniform increase in breadth on which the whole question rests.*

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* Huygens's measures were taken in 1657, Pound's in 1719.

But there is abundant reason independently of this for hesitation before admitting Mr. Proctor's premises. Thus micrometric measurements are liable to so many sources of uncertainty, that scarcely any two observers agree in giving the same result for the same object. Comparatively little weight can be attached to the breadth of the black division, in consequence of the great difficulty and uncertainty of the contacts of the points of reference with its borders. Other circumstances besides these show strongly how such values may be affected. The value of the semi-diameter of the ball, for instance, made when the rings are visible, is sensibly smaller than those made during its disappearance, a circumstance arising probably from the glare of the rings preventing the true border of the planet from being seen. Moreover, the following curious observation was made by Mr. Main, who fully investigated this subject some few years since, *viz.* that in two series of measurements which he made of the globe and rings in two distinct years, several of the first measures of each year made the breadth of the rings conspicuously less than that of the dark interval, that the difference between the two steadily decreased till they were equal, and that then the breadth of the ring became greater and that the ratio between them steadily increased. Now as it will not be denied that observations made continuously by the same person, with the same instrument, in the same way (supposing observer, instrument, and method to be of the best kind, which will be readily granted in the present case), are far more reliable than those which, being made by different persons, instruments, and methods, are subsequently reduced to a uniform standard by a presumed allowance for all variations, the legitimate conclusion from the above would seem to be that Saturn's ring system underwent, during each of the two years in which these examinations were made (and, if these are to be taken as particular instances of a general case, is continually undergoing), periodical changes of very great magnitude. Yet there are very few who, considering the uncertainties to which such measures are liable, would not hesitate to draw an inference of this kind, and who would not rather suspect the changes to be due to optical causes. But, as we have said, these results greatly affect the importance of a theory on the nature of the rings advanced by Mr. Proctor, and it is therefore probable that he has allowed his mind to be unduly biassed in the direction that would give it support. What are the rings? The chapter devoted to the discussion of this question is a highly interesting one, and the conclusion arrived at, after a review of the various conjectures that have been entertained on the subject, is that "they are composed of flights of disconnected satellites so small and so closely packed, that at the immense distance to which Saturn is removed, they seem to form a continuous mass." This hypothesis, which was first advanced by Cassini, may possibly be as true as it is ingenious, and the most recently expressed views in cosmical philosophy, if they do not support, certainly cannot be said to contradict it. This, however, is not saying much. A hypothesis so strange requires very strong evidence to render it acceptable, and we shall here inquire how far Mr. Proctor has *proved* his case, and whether the actual phenomena observed on the rings are so utterly irreconcilable with the idea of their continuous fluid or cloud-like structure as to render necessary its adoption in place of the one more generally received. The grounds on which he bases his opinion are partly *à priori*, partly certain phenomena which the hypothesis is supposed best to interpret, and partly exact mathematical inquiry. They may be thus stated:—First, rings of disconnected satellites are not uncommon in the solar system; the ring of asteroids between the orbits of the Earth and Mars; the belt of small bodies through which the Earth is supposed to pass twice in the year; the Zodiacal light, &c., being examples. We are not therefore to be unprepared for meeting with them in other situations, as for instance, around Saturn. Secondly, the following phenomena have been observed and require to be accounted for: all the rings often exhibit traces of divisions which form portions of different concentric circles, those on the bright ones being mottled, dusky, and very evanescent. The dark ring is transparent and allows the planet's disc to be seen through it undistorted. In 1856 a darkening of the inner bright ring was observed at the points where it lay nearest to the extremities of the apparent longer axis of the dark one. On the disappearance of the rings, a faint hazy bordering on either side of each ansa, and extending outwards to a variable distance from the ball nearest to which it was thickest, has more than once been seen. Lastly, as the result of independent mathematical inquiry, it was proved by La Place that for a solid flat ring to remain in equilibrium about a globe like Saturn's when subjected to the disturbances which Saturn's rings actually experience, it must rotate so as to give to each particle the same velocity that it would have if it were a free satellite, and, unless it were imagined to be in unstable equilibrium, that it must be biassed. The degree of bias, or the distance at which the centre of gravity would require to be from the centre of figure, he did not determine. Mr. Clerk Maxwell, taking up the question at this point, has proved that it would require to be nine times as far from its lightest as from its heaviest side, an arrangement which cannot exist, because if it did it would make the appearance of the system very different from what it actually is. Yet if the nebular hypothesis be true the rings must be solid, for on it their formation must have taken place in a period between that of the satellites and that of the globe, and as these extremes are solid, the intermediate bodies would probably be so likewise.

These, briefly, are the grounds on which Mr. Proctor constructs his hypothesis. Space forbids our doing much more, so far as the *à priori* part of the evidence is concerned, than to point out how little real analogy can be established among the cases of ring systems brought forward. Take that of the asteroids. The entire mass of these must fall very far short, on the most liberal calculation, of one-millionth part of the bulk of the Sun; while Saturn's rings, from their observed effect in disturbing Titan, are considered to be not less than $\frac{1}{118}$ of his mass. The Zodiacal light again has by no means been so certainly proved to result from flights of small cosmical bodies as to make it prudent to adduce this interpretation as a positive fact in Science, from which to illustrate other presumed analogous facts. The same may be said with regard to the employment of the Nebular hypothesis, as though, instead of being what it is, a highly probable supposition, it were an established certainty. But the second kind of evidence, that derived from observation, is the one on which the opinions of Mr. Proctor ought to find their securest support, and yet here their most serious difficulties are experienced. The author seems to feel this, and labours earnestly to disprove the existence of a cloud-bearing atmosphere, the presence of which, if it could be established, would satisfactorily account for many of the phenomena, and be contradictory to none, and would therefore render his hypothesis unnecessary. Yet it seems to us that, besides the phenomena mentioned, all of which either support or are not directly antagonistic to the hypothesis, there are others which, while they are readily explicable on the supposition of an atmosphere enveloping the rings, will, on any other supposition, remain strange. Such, for example. is the absence of any perceptible shadow on the planet's disc when the plane of the ring passes through the Sun. Now if the ring had even the least thickness ever ascribed to it, *viz.* 40 miles by Bond, it would be sufficient to produce a total eclipse of the Sun on Saturn's equator, if no qualifying agency operated, as it would subtend an angle more than double that subtended by the disc of the Sun as seen from the planet. As no such eclipse is produced, we must look for some cause competent to prevent it. Such a cause is readily found in a somewhat dense atmosphere, which, if it existed, would probably produce just the modification described, for the light, by refraction through it on both surfaces of the rings, would reduce the shadow to a slight and undistinguishable penumbra.* On the same supposition also another phenomenon, *viz.* the visibility of the ring system, when its unenlightened side is turned towards the Earth, is readily accounted for, while on Mr. Proctor's hypothesis these seem to us to meet with no explanation. Moreover, in support of his opinions, the author considers the greater visibility of the dark ring in modern times to be due not to improvements in the telescope, but to the fact that its formation is only of recent date. Yet it seems to us by no means certain that this ring was not observed nearly a century and a half ago. In the number of the Royal Society's Abstracts for April 6, 1720, the following notice appears of a paper read by Hadley:—"Within the ring he discerned two belts, one of which crossed Saturn close to its inner edge and seemed like the shade of the ring upon the body of Saturn, but when he considered the situation of the Sun with respect to the ring and Saturn, he found that the belt could not arise from such a cause." And again, in a later notice,—"The dusky line which in 1720 he observed to accompany the inner edge of the ring across the disc continues close to the same, though the breadth of the ellipse is considerably increased since that time." This was written in 1722.

In the chapter devoted to the discussion of Saturn's habitability the reasoning appears somewhat deficient in force. After expressing a belief from general analogy that the planet is inhabited, and after labouring apparently to prove a similarity between its conditions and those on the Earth, the author concludes that it is probably "not a suitable habitation for beings constituted like the inhabitants of our globe." But if it can be clearly shown that the physical conditions are irreconcilable with the existence of living beings like those which now tenant, or are known to have tenanted, the Earth, all other inquiries must be beside the question; and we cannot understand how, on the principles employed, inhabitants can be granted to Saturn, and yet denied to the Moon, or even to the Sun. In his notes on the habitability of the Moon, Mr. Proctor confines himself to the discussion of certain interesting but doubtful questions, and does not offer any opinion as to our Satellite's being the abode of living beings; yet, from the general tenour of his language, we infer that he considers it uninhabited. But why, if Saturn can be supposed to be the abode of beings different from any on the Earth, may not the Moon be supposed the abode of others different from those on either? The only life we know anything about is life in its terrestrial manifestations. This life requires certain conditions, and if they are absent it must be absent also. Further than that we are not warranted in going. We cannot say that, although the only kind of life we do know anything about is impossible because of the non-existence of some of its essential conditions, yet some other form of life probably is present. But are the conditions on Saturn such as necessarily to shut out life in this restricted sense? We cannot agree with the author that the dimness of the planet's light and the length of its year are so, when there is abundant proof of life on the Earth in situations from which light is absent altogether, and where the conditions, instead of only varying in long intervals, never vary at all. Many things have yet to be determined with respect to the light which reaches the outer planets, before it will be prudent to speak positively as to its dimness. The great reflective capacity of the globe and rings in the case of Saturn, and the photographic intensity of this reflected light, have already been clearly established. The matter is still under inquiry, and in the number of the 'Comptes Rendus' for June 5th is a very interesting communication from Father Secchi, in which the identity in many respects of the atmospheric conditions of Jupiter and Saturn is pointed out. As Mr. Proctor himself states, the light to the Earth was possibly much less in earlier times, when huge creatures of the bat kind were relatively very abundant. All his reasoning from palæontological data, however, is not so reliable even as this. It seems strange, for instance, to hear the cumbrous forms of extinct animals adduced as a reason for supposing that the dimensions of our planet were once much larger than at present, and therefore gravity at its surface less, when some of the hugest and most weighty of them lived only so recently as the later Tertiary period, during which there is no reason for thinking the size differed from what it is now.

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* *Vide* a paper by Rev. R. Dawes, in 'Monthly Notices, Astr. Soc.,' vol. for 1861.

The discovery of the disturbance of the periods of Jupiter and Saturn, known as the long inequality, when first made by Halley, was thought to throw doubt on the law of gravitation. The effect of mutual attractions in causing deviations from the simple elliptical orbits of the planets had long been recognized, but it was imagined that such disturbances must necessarily be of short duration only. Ultimately it was proved by La Place that the discrepancy, instead of militating against Newton's theory, served to establish it upon a firmer basis. The inequality was shown to result from the mean motions of the two planets being nearly commensurable, five times Saturn's being nearly equal to twice Jupiter's. The whole question is discussed with admirable clearness in one of the most interesting chapters in Mr. Proctor's book.

In the note on Chaldæan astronomy much curious information is given. The Chaldæans were probably among the earliest, if not the earliest, of astronomers. An old tradition, preserved by Berosus, states that Abraham taught the Egyptians astronomy and mathematics. But that they were acquainted with the true system of the universe does not seem so probable. In his effort to prove that they were, the author strives to dissociate them from the Greeks, who, it is certain, were not. He considers it clear that little connection exists between the mythology of the two people; yet the likeness is strong enough to show that one was probably influenced by, if not derived from, the other. The practice of colouring their statues and temples, for example, was common to the two. And if the Greeks did not derive their astronomical system from the Assyrians or Chaldæans, whence did they get it? While if they did, it seems improbable that they should have had a false system, while the people who taught them held the true one. That the Greeks derived their system from a people who dwelt far south of Athens seems as clear as that the Indian system was obtained from a country north of Benares, for Aratus, in his description of the constellation of the Altar, says that it is seen above the horizon for the same length of time as Arcturus is below it. But the constellation is not wholly visible from a latitude higher than 30°, a latitude far south of Athens, and agreeing with that of Persepolis and the country near the head of the Persian Gulf. With regard to the connection between the mythologies of Greece and Assyria, a connection which the author denies, we are tempted to quote the following very extraordinary prophecy by Niebuhr, which was uttered many years ago and reported to Mr. Layard by one who, as a pupil, heard it:—"There is a want in Grecian art which neither I nor any man now alive can supply. There is not enough in Egypt to account for the peculiar art and peculiar mythology which we find in Greece. That they did not originate it I am convinced, though neither I nor any man now alive can say who were the originators. But the time will come when on the borders of the Tigris and Euphrates those who come after me will live to see the origin of Grecian art and Grecian Mythology."

We cannot leave without expressing the strongest commendation of the beautiful engravings with which Mr. Proctor's book is illustrated. They are models of illustrative art. At the end is a concise but clear explanation of the astronomical terms used throughout the work, which will be found very useful to the general reader.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT BIRMINGHAM, September, 1865.

The President's Address.

There are periods in the career of every fortunate adventurer, especially in that of a trader, when a lull supervenes upon long-continued activity and a series of successes.

The natural occupations of such a brief period of repose, are a careful investigation of accounts; a stock-taking; the preparation of an accurate balance-sheet; and, as the sequence of these, a very comfortable kind of feeling that, whatever may lie hidden in the future, the past and present have at least nothing in them to be regretted, and are fit subjects for rejoicing and congratulation. Of course on such occasions the "managing man" plays the most conspicuous part, and comes in for a large share of the credit, if not on the balance-sheet, at least of the honour of having aided in producing such a gratifying document. Then it is that he is taken into the special confidence of "the house," perhaps into partnership, and then he finds the long labour of years crowned with an honourable reward.

Professor Phillips was for a long period of years the "managing man" of the "British Association for the Advancement of Science." He was at its foundation, and until very recently was its general secretary. His name is associated with all its successes; and in its poorer days, when the great mass of laymen thought little of the movement, he was as hopeful as he is to-day, and followed it through its stage of probation. Now a period of repose has come in the scientific world, and Professor Phillips, who is made the head of the concern for the year, has struck a balance sheet; talks to the partners concerning their past successes, fights their battles o'er again, reminds them what they said and did when they were young beginners, and what they think, and say, and do in the hey-day of their prosperity.

"Such, gentlemen," he says, "are some of the thoughts which fill the minds of those who, like Brewster, and Harcourt, and Forbes, and Murchison, and Daubeny, stood anxious but hopeful at the cradle of this British Association, and who now meet to judge of its strength and measure its progress. When, more than thirty years ago, this Parliament of Science came into being, its first child-language was employed to ask questions of nature; now, in riper years, it founds on the answers received further and more definite inquiries directed to the same prolific source of useful knowledge."

Is it not as we have said of the commercial adventurer?

"First, we embarked poor upon the great sea of thought, inquiry, and investigation, and were content to earn shillings: with the shillings we set out again, and returned with sovereigns; and now we are prepared to invest in large ventures, and to reap harvests of bank-notes." And he glances too at the ledgers of past years (referring his hearers to the 'Annual Volumes of Transactions' of thirty years), and tells them they will there read of profits heaped upon profits, concluding with a sigh that there is only one thing to be regretted; he is afraid that some of their ventures have been more profitable to third parties than they have been to themselves. But then he consoles himself with the philanthropic reflection, that it is all good for trade, and with that kindness of heart which characterizes old-established concerns having a larger business than they are able to manage themselves, he congratulates the partners in having been the means of starting a number of new establishments; and as these have after all been feeders, and have added *éclat* to the parent Congress, "the regret was soon lost in the gratification of knowing that other and equally beneficial channels of publication have been found" for transactions which the books of the great house were too small to contain.

These few remarks will convey to the reader some idea of what he may expect to find in the Address of the President, who has but little to say of the progress of Science since the last meeting, for there has been a remarkable lull in the business of scientific discovery and research. He touches cursorily upon the subject of Radiation, showing how recent experiments upon the passage of light have modified our ideas concerning the distances of the heavenly bodies from this world; and glances *en passant* at the physical and probable vital conditions of other spheres, and at the influence of changes in the sun's photosphere in creating magnetic disturbances upon the earth's surface. Spectral analysis, as applied to the determination of cosmical elements in the heavens, whether in suns, planets, satellites, or nebulæ, receives a passing notice; so, too, the application of Photography to Astronomical Science; and then the recent achievements of meteorologists are dwelt upon, and a touching reference is made to the "gentle spirit which employed this knowledge in the cause of humanity," and "which passed away, leaving an example of unselfish devotion,"—the late Admiral Fitzroy.

Crystallography and Chemistry (more especially synthetic) are brought under notice, and then we have a bright little panorama of the progress of Geological Science, and "step by step we are guided through the old Cambrian and Silurian systems, rich in Trilobites and Brachiopoda, the delights of Salter and Davidson; with Agassiz and Miller and Egerton we read the history of the strange old fishes of the Devonian rocks; Brongniart, and Göppert, and Dawson, and Binney, and Hooker unveil the mystery of the mighty forests now converted to coal; Mantell and Owen and Huxley restore for us the giant reptiles of the Lias, the Oolite, and the Wealden; Edwards and Wright almost revive the beauteous corals and Echinodermata; which with all the preceding tribes have come and gone before the dawn of the later periods, when fragments of mammoths and hippopotami were buried in caves and river sediments to reward the researches of Cuvier and Buckland, Prestwich and Christy, Lartet and Falconer."

Of Man, his antiquity and origin (the latter being linked by him with his brief passing observations on the "Origin of Species"), Professor Phillips speaks very cautiously, and in one instance, as it seems to us, too much so. He appears, notwithstanding his sincere protest to the contrary, to approach that bugbear of modern Science, "descent by modification," with timid steps, and with some apprehension lest he should offend the orthodox; and there will doubtless have been many a smile amongst our fast men of Science and thorough-going Darwinians, when they read his remark that "often out of the nettlesof danger, we have plucked the flowers of safety."

Unless we misapprehend the author's meaning (and it is not our fault if we do, for he is too cautious to be explicit), his observation brings before us again most vividly the staid "managing man," who, when he sees the younger members of the firm embark in hazardous ventures—employ steam and the telegraph instead of the safe old barque and, at most, the estafette, as he did—cannot help feeling that even if all be right, and the "flowers of safety" may be plucked "from the nettles of danger," the speed is far too great for his taste. Of course we revere and admire the white head none the less for its doubtful shake, and wish indeed that a little of its cautious contents might be transferred into the crania of some of those who, it would almost appear, are engaged to do the comic business of the Association; for whom modern views of Science are far too slow, and who conceive that they can best elevate themselves in the scale of humanity by bespattering and humbling their fellow-creatures.

But, whilst we can to some extent sympathize with Professor Phillips in the caution with which he approaches this "development" question, there is one matter in which we consider him to have committed a grave oversight.

The fathers of Science he pets and holds up time after time to admiration, and as our eye glances over his Address, we see the names of Priestley and Watt; Tyndall, Joule, Grove, and Rankin; Sabine, Kirchhoff, Rose, and Herschel; Humboldt and Glaisher (and Coxwell!); Airy, Hamilton, Whewell, Miller, Liebig, Hofmann, and many more of that rank; men who have earned their honours and their titles, and many of whom belong to the Upper House of "this Parliament of Science;" but we look in vain for the helping hand held out to the younger men, to those who will constitute the future of the Association of which Professor Phillips was one of the founders; to that class to which he essentially belongs.

It is true that "Naturalists' Field Clubs" are named, and we are told that "wherever and by whatever means sound learning and useful knowledge are advanced, these to us are friends;" but is the President aware that, two days after he delivered his Address, there met in a room of the Midland Institute, a few delegates representing the great body of Science-teachers of the country, to "consider the best methods of forwarding the Science Scheme of the Department," and of forming an Association "for advancing the interests of Science-teaching as a profession?"

It would be ungenerous if we were not to state frankly that we believe this omission in the President's Address to have been unintentional, for we know he is the first to recognize true merit and give his aid to rising talent and faithful labour in whatever sphere of society it is to be found. His year of office has fortunately but just commenced; and we trust that he will remember that if there has been but little of novelty of late in pure and experimental science, a great effort is just now being made to impart practical instruction to the masses by a number of disinterested (chiefly young) men, who will assuredly at no distant period be the mainstays of scientific truth.

The President's Address is couched in most beautiful language, and presents an example of what may be produced by one who has enjoyed an academical as well as a scientific training, and we cannot do him greater justice than by borrowing his opening remarks as a conclusion to this brief commentary; feeling assured that they have been, or will be heartily assented to by the devotees of Science in every land.

"Assembled," he says, "for the third time in this busy centre of industrious England, amid the roar of engines and the clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly falls upon the ear the accent of Science, the friend of that art, and the guide of that industry! Here, where Priestley analyzed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge. And when, on other occasions, we meet in quiet colleges and Academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilized, and the condition of human society exalted!"

PHYSICAL SCIENCE. (Section A.)

THE proceedings of this Section were opened on Thursday, Sept. 8th, by an able address from the President, W. Spottiswoode, F.R.S., in which the various discoveries and advances made in Physical and Mathematical Science during the year were passed in review. The President commenced by remarking that the great range of subjects comprised in this Section, and the multiplicity of papers submitted to it, have doubtless contributed to deter his predecessors in this chair from preparing addresses so elaborate and comprehensive as those delivered to other Sections. The custom, however, of prefacing the business proper by a short summary of subjects which have engaged the attention of philosophers during the past year, and which may therefore be expected to come before them during the present sittings, appears to be sanctioned by the wishes of the members, and might perhaps be followed without materially departing from that brevity which is here both customary and desirable.

In giving a notice of the papers read before this Section, space compels us to confine our remarks to those subjects only which have not before been treated of in these pages, and which appear of general interest.

The first day's proceedings commenced with the report of the Electrical Standards Committee, which was read by Mr. Fleeming Jenkin. In it were described the steps which had been taken with a view of obtaining an unvarying standard, and the subsequent distribution of coils, each expressing the British Association standard of electrical resistance. If these coils retained their value some confidence might be felt in the permanence of the unit they had arrived at. There were differences in the unit obtained by silver wire, &c., and the unit obtained by means of mercury, but it might be expected these differences would eventually disappear. The coils had been distributed widely, so that they would be available to actual electricians, and the telegraph companies had opportunities of using them. The unit had been introduced into India and our Colonial possessions, but it would take long before it was adopted on the Continent.

Mr. James Glaisher next read the report on "Luminous Meteors." He said the subject included the familiar appearance of shooting stars and fire-balls; and it was one which, long neglected, yet merited the consideration of those best able to speculate upon it. But few such appearances have been observed during the past year, partly owing to the presence of clouds, and partly to the absence of certain of the meteors usually seen in January, April, and August. A set of maps had been completed for the use of the committee, and they were presented with that report. Various instances were given of the appearance of meteors, and reference was made to the sound caused by them, a phenomenon which, it was hoped, would be explained by continued observation. Mr. Newton conjectured that these meteors were not fragments of old worlds, but that they were composed of matter out of which new worlds were forming. The committee hoped the grants would be continued, so as to enable them to add to the catalogue of nearly 2,000 meteors contained in the maps of the Association. Accounts were then rendered of different "fire-balls" which had been observed, and Mr. Glaisher concluded by referring to some of the details given in the appendices.

After a paper by Mr. Sabine, "On a new Method introduced by M. Siemens, of measuring Electrical Resistance," Mr. Hooper introduced the subject of "India-rubber as an Insulator for Telegraphic Conductors." He detailed the difficulties which had opposed the successful adoption of india-rubber insulation, and showed how he thought it might be advantageously adopted. In a certain stage of india-rubber manufacture, and under certain conditions, it became susceptible to decay; but there were means of securing a perfect insulation by india-rubber, and it had peculiar qualities which made it specially suitable for telegraphic cables. Twenty per cent. more messages could be sent by a cable insulated with india-rubber, than could be sent by one insulated with gutta-percha. The subject, therefore, had an important bearing in a financial point of view, as well as in other respects.

This paper was followed by a discussion upon the causes of failure of the Atlantic Telegraph, on which remarks were made by Messrs. Siemens, Fairbairn, Fleeming Jenkin, Cyrus Field, Capt. Selwyn, and O. Byrne.

Mr. H. C. Sorby then briefly described his new form of Spectrum Microscope. He mentioned its powers and uses in several instances, and amongst others, said that in identifying blood marks, they could employ it to detect the most minute stains: even of the one-millionth part of a grain they could have a perfect spectrum.

The proceedings concluded by a brief description by M. Claudet of his "Moving Photographic Pictures," detailing the means by which this effect was produced.

The proceedings of Friday, the 8th September, opened with the report of the "Lunar Committee," read by Mr. Glaisher, the chairman, which treated of the steps taken by the Committee during the past year to prepare a large and accurate map of the moon's surface.

At the conclusion of this report Mr. Birt (Secretary to Lunar Committee) read a paper "On the Progress of the Map of the Moon." Mr. Birt described by a diagram, how the moon's surface was divided and subdivided into sections, the larger parts being designated by a letter of the Roman alphabet, and the smaller divisions by the smaller letters of the Greek alphabet. By this means they could record any observations they had made, in such a way that observers coming after would be able to discover the locality. Having described the telescopes used in making observations, Mr. Birt went on to speak of various conspicuous objects on the moon's surface, such as the crater "Plato," the "Teneriffe mountains," the "Dionysius Crater," the "Railroad," the "Terra Photographica" of Mr. Warren De la Rue, &c., pointing them out in a diagram as he proceeded with his remarks.

The next communication was by Mr. Balfour Stewart and Mr. J. P. Capello, "On the Magnetic Storm of the Beginning of August last, as recorded by the Instruments at Kew and Lisbon."

Having described the means of ascertaining the value of the force which disturbed the needle, Mr. Stewart said the storm he was about to describe was the very great magnetic storm which many would remember from its having occurred at the time anxiety began to be felt about the Atlantic cable. It had many curious points, and was very similar to a great magnetic storm which occurred in August, 1859, being accompanied by great auroral phenomena and disturbance of the telegraph wires. There were instruments in the Observatories at Kew and at Lisbon, by the aid of which any disturbance was continually recorded by the aid of photography. The characteristics of a magnetic storm were not local in their nature, but cosmical, affecting different places at the same time. The way in which the storm of August affected the magnet was almost the same at Lisbon and Kew. It broke out on August the 1st, and lulled and then broke out again in the early morning of August 3rd. This lasted till midnight, and the disturbance then ceased altogether for twenty-four hours, renewing itself on the following day. Mr. Stewart exhibited drawings, showing the nature of the magnetic disturbance, and then compared it with the greater outbreak of August, 1859. Both consisted of two separate outbreaks, and both began during the hours of night or early morning. One peculiarity accompanying both storms was that there was at the time many spots in the surface of the sun. Many of them rapidly altered their size and their character, and one of these phenomena consisted of a bright spot of light rapidly crossing a dark spot on the surface of the sun. In conclusion, he said that it would be hasty, at this stage of our knowledge, to jump to any conclusion on the subject.

The physical papers this day concluded with an interesting notice by Dr. J. H. Gladstone, "On the Refraction Equivalent of Carbon;" the remainder of the papers being strictly mathematical.

On Saturday the 9th September, the proceedings opened by Professor J. D. Forbes reading a paper on "The Laws of the Conduction of Heat in Iron Bars," being a *résumé* of observations made with the aid of a grant from the Association. The subject had occupied his attention for the last fourteen or fifteen years, and was a very old problem. He had reported in 1852 on the progress he had then made in his experiments, and he now came forward to explain what he had done since in that respect. He had, without reference to either the precise mathematical or physical laws on which such estimates had been based by different philosophers, sought to determine the loss of heat from a given bar by direct experiments, and without necessarily inquiring what the precise law is. At the same time his experiments could not be quite regarded as conclusive, and he would be very glad if some member of the Association would extend them.

Mr. J. P. Gassiot, V.P.R.S., next read a paper, "On the Change of Form and Colour which the Stratified Discharge assumes when a varied Resistance is introduced in the Circuit of an extended Series of the Voltaic Battery." Mr. Gassiot operated with a battery composed of 4,000 insulated glass cells, and instead of sulphate of copper, as used by the late Professor Daniell, he put about a tablespoonful of sulphate of mercury into each cell. The elements, carbon and amalgamated zinc, were then introduced into the cells, which were subsequently filled with rain-water. When one of the wires of the battery is inserted in the water, and the other wire touches the moistened surface of the glass, but is not in actual contact with the water, a luminous discharge is produced, entirely filling a tube which is prepared to receive it, without any appearance of stratifications. On depressing the wire, discs of red light are rapidly produced from the positive pole, and on further depression nineteen only of these discs remain in the tube, and these are much increased in brilliancy and distinctness. On still further depression, other singular and highly beautiful effects are produced. Mr. Gassiot said that these phenomena, which he characterized as entirely novel, could be obtained with any insulated battery.

A paper "On Spectacles for Divers, and on the Vision of Amphibious Animals," was then read by Captain Galton. The author said those who had surmounted the usual repugnance of beginners to keep their eyes open under water, found, if they did so, that nothing was to be seen with distinctness—everything they could see at all, was seen through a haze; so that if the hands were held out to a distance of eight inches before the face, it would be impossible to discover the space between the fingers, even if they were spread out as widely as possible. If he looked through a tube into a vessel of water perfectly still, he saw all objects at its bottom with perfect distinctness, only a little out of their position through the effects of refraction. But upon lowering his head he found that the instant his eye touched the water all distinctness vanished—the convex surface of the eye-ball had indented the plane surface of the water, and turned the tube into a convex lens. If they desired to counteract this they must use a convex lens of such power that its effect should be exactly opposite to that of the concave water lens. A lens to answer that purpose he had made and now produced. Furnished with spectacles on such a principle, they might expect to see as well under water as on dry land. Men going down in diving bells did not require such aid; through the plate-glass inserted in the diving dress, they could see clearly when in the water. He designed his contrivance to be useful to the pearl-diver, to the sailor requiring to examine a ship's bottom, to men seeking in the water anything they may have lost there, and to bathers generally, to whom he promised that the possession of these spectacles would add much to their enjoyment. They would find they had acquired a new power. With respect to the amphibiæ, he thought their power of accommodating the vision was wholly inexplicable by any theory he had heard promulgated. The hippopotamus, otters, water-rats, and diving birds of various descriptions, apparently saw as well in water as on land. The cornea of the seal appeared to be very flat, but it was far otherwise with the rest of the amphibiæ.

Captain Selwyn then read a paper, "On some New Arrangement of the Poles in Magnets," in which he described an experiment he had made on this subject. A steel bar having been prepared and hardened as usual, was magnetized by any ordinary means—either by touch or an electric current. Then, either at the centre or any other point of the bar, where it was desired, the temper was taken out of the bar by a rod of heated metal or by a blow-pipe, when it was found that this operation separating the bar into two magnets, the ends of the bar still remained respectively north and south.

The last paper in the Section this day was one by Mr. Harrison, "On the Heat attained by the Moon under Solar Radiation." After referring to various theories on the subject, Mr. Harrison expressed his opinion that a small modicum of heat having been detected in the course of researches into the question made by Professor Smythe at Teneriffe, justified the assumption that the moon's radiant heat was expended in dispelling cirri cloud and vapour before it reached the earth's surface. The heat of the moon at the last quarter, or a day or two after entering that phase, seemed to be greater certainly than when at the full.

On Monday, the 11th September, the proceedings in Section A commenced with the Report of the Balloon Committee, read by Mr. Glaisher. It stated that the committee had been re-appointed last year, in order, 1st, to examine the electrical condition of the air at different heights; 2nd, to verify the law of the decrease of temperature, as found from summer-day observations already made, with day observations at other seasons of the year, but principally in the winter and adjacent months; 3rd, magnetical experiments; observations with the spectroscope, the currents of the atmosphere, solar radiation at different heights, and hygrometrical observations, though secondary, were to be held as very important subjects of investigation; 4th, to arrange for observations at night, and to make such observations if possible. With respect to the first subject, no farther progress had been made, the instrument prepared for the purpose not having been rendered available for use. Under the second and third heads some progress had been made, though not to the extent anticipated. As to the fourth object, no night observations had actually been made. To take such observations it was imperatively necessary to have some means of illumination, so that the instruments could be read. Various suggestions had been made on this point, but the best plan seemed to be to employ a Davy lamp. Two such lamps had been made of copper, for Mr. Glaisher, so that the proximity of magnets did not affect them. Experiments had shown that these lamps might be used with perfect safety, and that they kept well alight, besides affording a source of grateful warmth not before possessed. All necessary arrangements were now made for night observations, and a series of such observations would be very useful, though there were no results yet for presentation. The same instruments, with the addition of a fine spectroscope and a delicately-mounted magnet, had been employed, as during the previous year. The instruments were attached to the outside of the car, and were easily read in that position. Up to the last meeting of the Association twenty-two ascents had been made, of which seventeen had taken place in June, July, August, and September, and five only in the other months of the year, *viz.* one in January, one in March, two in April, and one in October. Of the summer ascents, one had been made in the morning, and the rest in the afternoon or evening. The committee considering that day and night experiments in summer had better be brought together before more were made, Mr. Glaisher devoted all his efforts to secure as many ascents as possible between October and April, but he had succeeded in three instances only, on December 1st and 30th, 1864, and on February 27th last. The three ascents were made from Woolwich, and the paths of the balloon were shown in diagrams. The small number of ascents was due to winter being an unfavourable season for balloon experiments. But as with regard to the progressive diminution of temperature with elevation, the diffusion of vapour in the atmosphere, the density of clouds, their extent and currents in the atmosphere, and all connected with the higher regions of the atmosphere in winter, we are in almost entire ignorance; on this account winter is the most important season for experiments. The winds prevailing in the higher regions in January and February were W. and S.W. This was unfortunate in regard to the ascents, as it necessarily shortened their duration.

Mr. Glaisher's disappointment at finding his time for observation always cut short by the inevitable tendency of the balloon towards the sea, was compensated for when he considered the high importance of the continuance of the south-west winds in winter. Constant observation last winter, from October to March, had found the wind always in the same direction, whenever it was possible to determine the motion of the upper air, no matter from what quarter the earth-wind came. The high temperature we experienced in winter seemed due greatly to this current, which met with no obstruction in its course towards us, but blew directly hither and to Norway over the Atlantic. These winds only reached France when they had passed over the whole of Spain and the Pyrenees, and they had then become so much cooled that France derived comparatively little benefit from them. This apparently caused the more severe winters in that country. It was probable that our milder winters were due to these winds.

At every opportunity during these ascents, Mr. Glaisher had directed the spectroscope to the sun, and always saw a very fine spectrum with many lines, more numerous than on earth, and better defined. The spectrum usually extended from A to far beyond H. The spectrum was perfect with a much narrower opening of the slit than on the ground, and lines could therefore be clearly resolved which could not be seen from the earth. A blackened bulb thermometer, placed near another carefully screened, for determining the temperature of the air, generally read the same as the latter. No tinge of ozone was shown on the test papers in any of the journeys.

W. C.

Chemical Science. (Section B.)

In reviewing the proceedings of the Chemical Section, it should at once be stated that the interest attaching to the week's transactions lay not so much in the contributions formally presented to the meeting, as in the supplementary observations which were frequently offered by way of discussion upon the points raised in the authors' papers. The members of the Chemical Society seemed to have adjourned in a body to one of the spacious class-rooms of King Edward's School; and Dr. W. A. Miller, when delivering his inaugural address, was ably supported by Professors Frankland, Hofmann, and Williamson, and surrounded by many of those who commonly attend the *séances* at Burlington House. The place of meeting this year held out many inducements to the technologist; and the facilities afforded for the study of the leading industries of the great Midland Metropolis were fully taken advantage of; amongst those manufactories which offered the greatest attractions for the chemist, may be particularly mentioned the Glass and Chemical Works of Messrs. Chance, the Phosphorus Works of Messrs. Allbright & Wilson, the Electroplating Factory of Messrs. Elkington, Mason, & Co., the Birmingham Gas Works, and the Iron and Engineering Works of Messrs. Lloyds, Fosters, & Co., of Wednesbury, where the process of converting cast-iron into Bessemer-steel was practically demonstrated. The excursion programmes provided ready means of visiting the objects of interest in the surrounding districts, such as the Burton Breweries, Worcester Porcelain Works, and the Potteries and Blast Furnaces of Colebrook Dale and South Staffordshire. Some special points of great interest in connection with the metallurgy of copper were shown at the Stephenson Metal Tube Works, Birmingham, and the effects of heat and pressure upon a variety of mineral substances were well illustrated in the "Patent Jet" and "Rock Jewellery" Works of Messrs. Dain, Watts, & Manton. The process of effecting the electro-deposition of brass, copper, tin, and other metals were likewise thrown open to inspection. These were, indeed, deemed of sufficient importance to be taken cognizance of by the President in his inaugural discourse, in the course of which, after alluding to the signs of progress manifested in the further development of the metallurgy of magnesium, thallium, lithium, indium, and other rare metals, they were pretty fully described. The exposition of the latest views regarding the chemical theory and nomenclature, and the progress made during the past year in several branches of organic research formed the burden of Dr. Miller's introductory statement.

The sectional proceedings commenced with the exhibition of a "New Form of Spectrum Apparatus as applied to the Microscope." Mr. H. C. Sorby described the instrument, and proved that by its aid suspected blood-stains on linen fabrics, &c., could be recognized by the production of dark bands occupying positions in the spectrum identical with those furnished by blood itself, seen by indirect vision at the same time in the field of the miscroscope.

Professor F. A. Abel read a paper, entitled "Notes on the Compounds of Copper and Phosphorus," in which he described certain definite combinations of these elements, but particularly referred to the beneficial effects of adding small proportions of phosphorus to melted copper or bronze; which metals, when so treated and cast in iron moulds, or "chills," offered very great resistance to tensile strain, and seemed applicable to the manufacture of heavy ordnance. Copper alloyed with 0·5 per cent. of phosphorus, supported 38,380 lbs. per square inch, whilst metal in which the proportion of phosphorus was augmented to 1·4 per cent., did not break until the weight amounted to 47,000 lbs. on the same area: this result being nearly double that representing the strength of the purest variety of commercial copper. In the course of discussion it was stated that the employment of phosphorus in the manufacture of wire for telegraphic cables could not be recommended, since the existence of the merest traces of the phosphide injuriously affected the electric conducting power of the metal. Messrs. A. and H. Parkes, of Birmingham, appear to have been working for many years under a patent, in which the advantage of using phosphorus in order to secure a sound casting in copper is a special feature.

A communication "On Silicium in Iron," and two other papers of minor interest by Dr. T. L. Phipson, were read, and afterwards commented upon by several speakers. The general expression appeared to be adverse to the opinion advocated by Dr. Phipson, *viz.* that the physical characters of iron and steel are mainly determined by the state of combination of the silicium, which it is asserted may exist in the metal in two distinct modifications. Dr. A. Voelcker described an interesting specimen of *Boiler Deposit*, which was said to contain a considerable proportion of hydrate of magnesia in association with sulphate of lime. The same author likewise directed attention to some *Phosphatic Nodules*, lately discovered at Nant Gwynnant, North Wales.

Dr. Angus Smith exhibited a simple form of apparatus for determining the presence of carbonic acid in vitiated air, which he found particularly applicable to the testing of the atmosphere in factories and mines. An india-rubber ball, connected with a bottle holding baryta water, served, by passing through the liquid a definite volume of air to be tested, to indicate roughly the amount of carbonic acid present in the air. The point of first formation of an opalescence, or permanent precipitate, was that which guided the operator, after a few comparative trials, to a knowledge of the degree of purity or contamination.

Professor A. W. Williamson's report "On the Gases evolved from the Bath Waters," gave rise to an animated discussion upon certain difficulties of gas analysis, particularly the production of carbonic oxide whenever pyrogallic acid was used to absorb oxygen from a gaseous mixture. Dr. Crace Calvert, in a paper entitled "Notes on the Action of Acids on some Metals and Alloys," described the conditions under which zinc, copper, and brass are soluble in sulphuric acid of different degrees of dilution.

The preparation of a material called "Parkesine" was briefly described by Mr. Owen Rowland, and its use for coating telegraphic wires advocated on account of its great insulating properties. It was superior in these respects to gutta-percha, india-rubber, or ebonite. Dr. Finch described certain methods of "Utilizing Blast Furnace Slags," which were said to be practised in France and Germany. The waste material was cast in the form of huge rectangular blocks, which after being slowly cooled were trimmed by the mason and used for street paving. The presentation of the Report of the Committee on Gun-cotton was deferred until next year; Mr. Manning Prentice gave, however, a short account of the manufacture of Gun-cotton at Stowmarket, and described an improved method of preventing its decomposition by keeping it always moist. He recommended the use of Gun-cotton cartridges for sporting purposes, and stated the leading advantages to be that of not fouling the barrel, whilst the piece when fired was subject to less recoil than in the case of gunpowder.

Dr. David S. Price read an important communication, "On the Action of Light upon Sulphide of Lead, and its bearing upon the Preservation of Paintings in Picture Galleries." The author found that the action of sulphuretted hydrogen upon lead-salts was greatly influenced by exposure to the sun's rays, and that recently-formed black sulphide of lead became bleached by conversion into sulphate whenever the light had access. Hence it was not always desirable to screen the face of oil paintings from the sunshine, but on the contrary, an old practice seemed to confirm the author's scientific conclusions, and he would recommend the occasional restoration of such works of art by freely exposing to the light any pictures which may be showing the effects of a tainted atmosphere.

A very interesting discussion followed the reading of Dr. T. Wood's paper, "On the New Formulæ, with reference to Schools and Examinations," the result of which lent authority for the general use of the new system as being at once more truthful and better adapted to the wants of the pupil than the old chemical notation. The President and Professor Williamson spoke strongly in favour of its general adoption, and urged the necessity of requiring its employment in all public examinations.

The crystalline forms of Melaconite and Tenorite were defined by Professor Maskelyne, and a most interesting account of certain minerals from Norway and other localities was furnished by Dr. David Forbes, who exhibited a collection of beautiful specimens in the Museum of the Midland Institute. "The Sanitary and Economical Aspects of the Sewage Question," and "The Utilization of Sewage, as conducted at Stroud," were treated of respectively by Dr. A. Hill (Borough Analyst), and by Dr. H. Bird, of Cheltenham, who coincided in advocating a return to a more primitive system of house drainage, an opinion which received the support of Sir John Bowring.

Messrs. Ladd and Oertling pointed out some important errors in the indications of the Sikes's Hydrometer, which seem to demand the attention of Her Majesty's Board of Inland Revenue. A new vacuum apparatus and Thermo-electric Pile were exhibited by Mr. William Ladd; a water barometer by Mr. Alfred Bird; and a variety of optical instruments by Mr. John Browning and Messrs. Powell and Leland, of London, and by Messrs. Field and Co., of Birmingham.

An interesting series of Photographs of the Interior of the Great Pyramid, taken by the aid of the Magnesium Light, were forwarded for exhibition by Professor C. Piazzi Smyth, together with a short statement of the difficulties encountered in their production, which, in the form of explanatory notes, was read by Mr. W. White. The collection of photographs included several views of the granite coffer in the King's Chamber, taken with measuring rods attached, and the author asserts that the real dimensions closely accord with those adopted by the late Mr. Taylor, and that the cubical contents are precisely the measure of four English quarters of wheat. Professor Smyth seems to have found great difficulty in ensuring the continuous combustion of the magnesium wire, due partly to the deficient supply of oxygen in the interior of the Pyramid, for the ventilating passages opened by Colonel Howard Vyse in 1837 were found to have been completely stopped up with sand and stones by the Arabs; and further, the cloud of magnesium smoke required so long a time to deposit, that it was found impossible to make more than one experiment in the space of twenty-four hours. A very remarkable photographic effect resulted from the trial as an illuminating agent of a pyrotechnic mixture composed of magnesium filings and mealed gunpowder; and the before-mentioned views of the interior were supplemented by some excellent photographic representations of the principal external features of the Great Pyramid.

J. S.

GEOLOGY. (Section C.)

THE business of this Section was opened by the address of the President, Sir R. I. Murchison. He specially enlarged on the discovery of organic remains in rocks of higher antiquity than those in which they were known to occur at the time of the last meeting at Birmingham, and yet he argued that the discoveries, instead of interfering with, sustain the truth of that doctrine that the lowest animals alone occur in the earliest zone of life, and that this beginning was followed through long periods by creations of higher and higher animals successively. As a striking example of the existence of a well-marked period beyond which no trace of a great group of animals has ever been found, he appealed to the existence of the remains of fish in the Upper Silurian rocks, and their entire absence in all of higher antiquity; years of careful investigation having made the negative evidence very strong, and leading us to conclude that there was a beginning as well as a progress of creation. Another point specially brought before the Section was the inadequacy of the modern intensity of existing causes to produce some of the phenomena of excavation and denudation, the author arguing that we cannot apply to flat regions, in which water has no abrading power, the same influence which it exerts in mountainous countries; and that we are compelled to admit that the convulsive dislocations of former periods produced many of those gorges in which our present streams flow.

The Association may well congratulate itself this year on the satisfactory results of explorations undertaken at its request, and aided by grants from its funds. None of them excited more general interest than the report of the committee on the explorations of Kent's Hole, Torquay, carried on under the superintendence of Mr. Pengelly and Mr. Vivian. Much still remains to be done, and no doubt will be accomplished by means of the additional grant made at this meeting. However, so far the results are of the greatest interest and eminently satisfactory. The inquiry has been conducted with the utmost care;

such a large amount of fossil bones have been discovered that it will be possible to supply most instructive series of specimens to the leading museums of the country, and the contemporaneous existence of man and various species of large extinct mammalia appears to be very well established. So far no human bones have been found, but a considerable number of flint implements of such forms that their artificial origin, through the agency of man, admits of no reasonable doubt. In connection with cavern explorations, we may allude to those undertaken in the caverns in Malta, under the superintendence of Mr. Adams. These have yielded, so far, the remains of two species of elephants, remarkable for their diminutive size—Mr. Busk having lately determined another species in addition to that described by the late Dr. Falconer.

Another report, not only of local, but also of great general interest, was that by Mr. David Forbes, on the igneous rocks of Staffordshire. One of the striking conclusions which we may draw from it, is that geologists ought not to rely so exclusively on mere appearances, but should pay more attention to the chemical analysis of rock masses. Studying them in this manner, the author concludes that all the different varieties of these rocks may have been, and probably were, derived from one simple source; and that the difference in their aspect was caused by the manner in which they were erupted, or by the extent of subsequent alteration or decomposition.

Another paper by the same author, "On the Existence of Gold-bearing Eruptive Rocks in South America," which have made their appearance at two very distinct geological epochs, corrected certain generalizations derived from the study of gold-bearing rocks in other countries, and was moreover valuable as showing that the gold was derived from the granitic rock itself. The author argued that the gold-bearing quartz veins were the direct continuation of the quartz of the granite, which had penetrated into fissures in the surrounding rocks, leaving the other constituents behind. In proof of the existence of gold in the igneous rock itself, he mentioned a case in which the decomposed granite is worked and washed to obtain the included gold.

In a paper "On Glacial Striation," Professor Phillips, the President of the Association, brought before the Section the question of the glacial origin of lakes. He argued that in studying this subject it would be well to apply more rigorous methods of research than those too often adapted; for it is a mechanical problem, capable of solution on accurate mechanical principles. Applying these to the special case of Wast Water in Cumberland, he contended that the amount of mechanical force due to the pressure of the ice existing in the upper steep part of the ancient glacier, would not be sufficient to effect the excavation of the lake in the lower and comparatively level part of its course.

A remarkable example of the light which ancient history and archæology may throw on certain comparatively modern geological phenomena, was furnished by a paper by Mr. R. A. Peacock. On comparing early records with the present configuration of the coast of France and of the Channel Islands, the author concludes that most extensive changes have taken place during the historical period; subsidences, varying up to as much as 100 feet in some cases, having occurred over considerable areas, as shown by a large coloured map illustrating the subject. In a very analogous paper, by Mr. Pengelly, "On the Isolation of St. Michael's Mount, Cornwall," it was argued that subsequent to the occupation of the country by the ancient Britons, who called this "the hoar rock in the wood," but yet anterior to the period of the Romans (Diodorus Siculus, speaking of it as an island), the rock had been so separated from the main land as to be an island at high water. The author contended that separation had been effected, not by the encroachment of the sea, but by a general subsidence of the land.

Amongst the papers related to districts of which the geological structure is very imperfectly known, special reference may be made to that by the Rev. W. Holland on the Geology of the Sinaitic Peninsula. A most instructive collection of fossils was exhibited, including cretaceous and older forms, amongst which was a well-marked stigmaria. Some comparatively very recent deposits yield distorted varieties of cardium, and indicate that the Red Sea was more extensive, and that its waters were far less salt than at present, and similar to those of the Baltic.

Amongst the most striking palæontological discoveries brought before the Section was that of a fossil spider, from the coal measures of Upper Silesia, described by Professor Römer of Breslau. A new large saurian from the Wealden of Brook, Isle of Wight, was described by the Rev. W. Fox, for which the name Polacanthus has been proposed by Professor Owen, in allusion to the remarkable spine-like bones which ran along the sides of the body and tail. A number of new leaf and other forms from the plant-bed in Alum Bay, Isle of Wight, were described by Mr. W. S. Mitchell, amongst which were some well-preserved flowers. The interest attached to these beds has induced the Association to make a grant for their more complete exploration.

It is, of course, always desirable that at all meetings of the Association local geology should be well represented. On this occasion the Silurian, carboniferous, and Triassic rocks and their fossils, as well as the peculiarities of the superficial drifts, were described by Messrs. C. Ketley, S. Bailey, H. Johnson, W. Molyneux, C. Twamley, Rev. P. B. Brodie, and other local geologists. Though not forming part of the proceedings of the Section, we may class with these communications the lecture of Professor Jukes on the extension of the coal measures below the Red Rocks of the neighbourhood of Birmingham. The chief point impressed on the audience was the fact, that, though coal measures might exist at a great depth, it by no means follows that after sinking through a great thickness of rock any valuable beds of coal would be found. He particularly insisted on the necessity of anyone who undertook such a project being prepared to carry it out in a thorough manner, since it was impossible to meet with coal measures except at a great depth; and he argued that a matter of such great national importance as the accurate solution of the problem, ought to be carried out at the national expense.

H. C. S.

ZOOLOGY, BOTANY, PHYSIOLOGY. (Section and Sub-section D.)

THE business of Section D was opened by a few introductory remarks by the President, Dr. T. Thomson; and that of the Sub-section by an eloquent address by the President, Professor Acland of Oxford. Dr. Acland commenced by discussing the relation which biological science bears to medicine. He pointed out that its objects are unquestionably, 1st, simply to ascertain what are the facts in a certain department of nature; 2nd, how they may be made of value for the practical exigencies of mankind. So that however desirable it may be to have physiology cultivated by persons whose undivided attention can be bestowed upon it, yet that it is the special duty of the physician to promote the advancement of physiological knowlege to the utmost of his power. He argued that physiology was not a subordinate subject, but that it included a knowledge of the characteristics on which the classification of all living entities is based. He showed that the hindrances to a perfectly free study of physiological science arose, 1st, from the intrinsic difficulty of the subject; 2nd, from the prejudices of mankind. And he concluded by pointing out how important the cultivation of the subject is in connection with public health and practical medicine.

One of the earliest papers read was by Professor Lionel Beale, "On Vitality," in which he explained those views regarding the structure of organic tissues which are so intimately associated with his name, and which as they have been made known by him in so many quarters, it is needless for us to enter into here. He contended for the existence of a vital power distinct from the chemico-physical forces operating in the organism.

He was followed by Dr. J. H. Bennett, who advocated views regarding the origin of many textures opposed to that of Dr. Beale, and, taking the pus cell as an illustration, he stated that it did not arise within a pre-existing cell, but that it was produced by an aggregation of molecules in an exudation.

Various interesting questions connected with food and diet were discussed by Dr. John Davy. He considered that a diet of animal food was by no means incompatible with fatness, whilst on the other hand a vegetable diet did not necessarily tend to the production of fat. He expressed doubts of the accuracy of the theory, that if a man has not a given quantity of food, sufficient to sustain his physical powers, his health must necessarily suffer. He advanced various illustrations that a deficiency of food, though causing temporary weakness, did not produce any permanent ill effects, and argued that the good diet of gaols really fed the prison population, and that therefore in them the lowest diet-scale should be used which would not necessarily engender permanent injury to the constitution.

The passage of Entozoa into the human body through eating impure food was discussed by Dr. Cobbold, who stated that beef infested by tape-worm larvæ was more frequently the source of that parasite than pork, whilst Dr. Fleming pointed out that the great prevalence of tape-worm in Birmingham was due to the consumption of measly pork.

Various points in the anatomy and physiology of the brain were treated of in these Sections. Dr. W. Dickenson read an elaborate paper "On the Functions of the Cerebellum," which was based partly on experiments on the lower animals, and partly on pathological observations. The general conclusion arrived at was, that the function of the cerebellum is to supply the voluntary muscles of the trunk and limbs with self-regulating motive power. Dr. Crisp, from a comparison of the weight of the brain in proportion to the weight of the body, in a number of animals which he had selected, came to the conclusion that the relative weight of the brain in proportion to the body was an indication of intelligence, for no animal with a relatively small brain possessed a great amount of intelligence. A description of the external form of the brain of the Orang was also given by the same gentleman. A discussion, "On Phrenology as an important Department of Ethnology," was opened up by a paper read by Dr. Prideaux, without however eliciting any new facts. Papers in other departments of human and comparative anatomy were also read. Dr. Humphry gave an account of the skeleton of a woman, aged 104, who had died from accumulation in the bronchial tubes. The cartilages of the ribs were as soft as in early life: the walls of the skull were unusually thick, and the skull weighed 27½ ounces, or 6 ounces more than the average. The thigh bone, on the other hand, was singularly light, and weighed only 5 ounces. Dr. Rolleston related the results of his observations on the body of a man supposed to be 106 years old. The skull in his case was so thin and soft, that it could be cut with a knife. Dr. Humphry also expounded his views on the homologies of the lower jaw and the bones connecting it with the skull in the Ovipara. He maintained that the several pieces of the oviparous jaw are represented by the articular and other parts of the mammalian jaw, and that the quadrate and quadratojugal bones are represented by the glenoid and zygomatic parts of the temporal of mammals. Dr. Rolleston described certain points in the anatomy of a fish, and a crustacean from the Mammoth Cave, Kentucky. He showed that the former possessed no abdominal fins, that the latter nearly resembled our own cray fish, only that it was more minute, and though it had been described as blind, yet a careful examination showed it to possess eyes, though these contained no black pigment, and had no facets at the corners. The same gentleman also described various features in the anatomy of Lumbricus terrestris, more especially in connection with the variability in the number of the rings and the arrangement of the muscular system and salivary glands. An elaborate paper, "On Annelida from the Coast of Guernsey," was read by Mr. E. Ray Lankester. He had obtained about seventy-seven specimens, amongst which were three entirely new. The Rev. A. M. Norman described the structure and mode of development of the Salpa spinosa, as he had observed it at Guernsey.

Mr. William Turner gave the results of a number of dissections, more especially of the flexor muscles of the fingers and toes, and of the supra-condyloid foramen occasionally occurring in the human arm, from which he concluded that a great amount of variability was manifested in the construction of the human body in different individuals, that in the development of each individual, a morphological specialization occurs both in internal structure and external form, by which distinctive characters are conferred, so that each man's structural individuality is an expression of the sum of the individual differences of all the constituent parts of his frame.

Dr. W. H. Lightbody communicated a paper "On the Vascular Arrangements of the Cornea," in which he pointed out that the capillaries which extended for a short distance into that structure were enclosed in spaces, which, from the pale, rounded, lymph-corpuscular-looking cells they contained, he believed to be lymphatic vessels.

Dr. George D. Gibb refuted the view recently propounded by M. Guinier, of Montpellier, that in the act of swallowing the food came in contact with the vocal cords.

Dr. Richard Norris gave an account of a series of experiments which had led him to the conclusion that rigor mortis is not a contraction, either energetic or otherwise, of muscular tissue. It is a suspension of the property of extensibility, probably due to solidification (coagulation?) of a fibrenous (?) material, contained in the interfibrillar juices of the muscles, as asserted by Brücke and Kühne, the resolution of which, by incipient decomposition, restores to the muscles their mobility.

An elaborate report, "On Amyl Compounds and their Physiological Action," prepared at the request of the Association, was read by Dr. B. W. Richardson, and the committee of the Sub-section recommended a renewal of the grant to Dr. Richardson, in order that he might continue his researches on these bodies. The same gentleman also communicated a paper, "On Ozone," in which he summed up all the physiological facts which could be relied on respecting that body. Dr. Arthur Gamjee communicated the results of a number of experiments, which confirmed those of Kühne, that ammonia did not exist in the blood.

Mr. Stainton called attention to the fact that, out of eighteen species of the genus Laverna, no less than ten derived their nourishment, when in the larva state, from plants of the order Onagraceæ. Messrs. Westwood and Spence Bate discussed various questions relative to the Anceus, which they considered to be a distinct genus, the Praniza of Leach being apparently the female anceus. Mr. E. Newton related the discovery of bones of Didus in the Island of Rodriguez. The Rev. F. Hewlett described various bones of the Moa, discovered in New Zealand, in the same oven as those of the Pig. Sir J. Lubbock described the metamorphoses of Ephemera (Chlæon).

Messrs. J. G. Jeffreys, A. M. Norman, and C. Spence Bate, gave in their reports of dredging expeditions in the Channel Islands, on the coast of Aberdeen, and on the marine flora and fauna of the south coasts of Devon and Cornwall.

Dr. Mörck read papers "On the Classification and Zoological Affinities of the Mollusca."

Mr. Frank Buckland made his report on oyster culture, in which he showed that the young spat preferred the following objects to cling to,—the shells of oysters, muscles, periwinkles, whelks, pieces of crockery, glass, tiles, tobacco pipes, iron, and wood, the first-named being those usually selected. The fascines or faggots of wood employed in some localities would not pay the expense of laying down.

Dr. P. L. Sclater gave an account of the birth of a young hippopotamus in the gardens of the Zoological Society at Amsterdam; and Mr. Thomas Moore, of the Derby Museum, Liverpool, described some improved methods of displaying birds in public museums, which he had introduced into that institution.

A report, "On Zoological Nomenclature," prepared by a committee, was read by Sir William Jardine. They had come to the conclusion that permanency of names and convenience of practical application were the two chief requisites, and they deemed it undesirable to disturb by any material alterations the rules authorized by Section D, at the meeting of the British Association in Manchester, in 1842.

An important resolution, respecting Section D and its Sub-section, was arrived at by the General Committee of the Association:—That in future years Section D be entitled 'Biology,' and that the Council be charged with making the requisite arrangements to subdivide it into such departments as may seem best fitted to ensure its practical working.

W. T.

GEOGRAPHY AND ETHNOLOGY. (Section E.)

THE geographical subjects which came before the meeting were of most varied interest. Commencing with Europe, there was a cluster of three papers on the Mont Blanc range of the Alps, contributed by Alpine climbers and geographers. The one of most scientific interest was undoubtedly that of Mr. A. Adams-Reilly, "On a recent Survey of the Chain of Mont Blanc;" although a paper by Mr. E. Whymper, the hero of the Matterhorn, "On the Ascent of the Aiguille Verte,"—a mere narrative of bold adventure,—seemed to have most attractions for the crowded audience assembled on the day the three memoirs were read. Mr. Adams-Reilly is now well known as the author of a much improved detailed map of the Mont Blanc chain; he exhibited to the Section the large original drawing of his map; and his paper was descriptive of the various surveys which had been undertaken in the district, and the causes of the gross errors that existed in other maps, especially that published by the Swiss Federal Survey. The errors in their delineation of the chain arose from the fact that only a small portion of it belongs to Swiss territory, the rest being Sardinian, and the official surveyors of the two countries working at different times up to the summit of the ridges constituting their respective frontiers, produced maps which could not be fitted into each other. The Swiss in dovetailing the Sardinian map with their own made a most serious blunder, for their surveyors, in carrying their triangulation up the *eastern* side of one of the ridges on the Sardinian frontier, which had been already triangulated by the Sardinians on the *western* side, mistook the position, and inserted it on their map as a separate mountain chain. In doing this, and to reconcile it with the rest, it was necessary to annihilate four square miles of glacier, and to pull together into one two mountains which had previously stood apart, different in name, separated by a distance of more than a mile, and differing in recorded height by nearly 700 feet. Mr. E. Whymper, as related in his own paper, was the companion of Mr. Adams-Reilly in his survey during the summer of 1864. Their intentien was to have ascended the Aiguille Verte together, but the difficulties seem to have been too great; and it was reserved for Mr. Whymper alone, with two guides, Almer and Biener, to accomplish the feat during the present summer. The third Alpine paper was by Mr. G. S. Mathews, on the "Ascent of Mount Blanc, by the Glacier de Brenva." The author was highly complimented by Professor James Forbes, who made a few observations on the three papers, for having accomplished what had previously been deemed impossible; and for having added several facts of great topographical importance, during his ascent.

Turning to Asia, there were first two papers on Palestine: one, a "Report of the Results of Surveys relating to the Water Supply of Jerusalem," by Capt. T. M'Neill, and Capt. Wilson, C.E.; and the other, "On the Exploration of the Holy Land, as proposed by the Palestine Exploration Fund," by Mr. G. Grove, Secretary to the Fund. The first mentioned seemed to belong as much to Engineering as to Geography, but communicated several new and interesting facts relative to the physical aspects of the neighbourhood of Jerusalem. The authors explained the non-existence of rivers by the porous nature of the soil, washed down the steep hill sides by heavy rains, and accumulated in the valleys, for instance in the valley of Urtas, to the depth of at least twenty feet. The surface water sinks through this and runs in subterranean courses to a great distance. It was only by reconstructing the terraces of the hill sides which probably existed formerly, and thus preventing the soil from being washed down, that the ancient fertility of the land could be restored. Mr. Grove's paper was of the nature of an appeal for support to the scheme of exploration proposed by the Palestine Exploration Fund, which after a very fair commencement seems now to require a fresh stimulus. In the interesting discussion which followed the reading of the paper, the Rev. H. B. Tristram spoke of the much better chance of discovering ancient Jewish remains, in retired country places than in the city of Jerusalem, where the Society intended to commence operations. He gave his own experience in Tunis as an example. Whilst there he was for some time the companion of Dr. Davis in his excavations on the site of Carthage. They had to dig through stratum after stratum of Roman and more recent remains before they reached a single Punic inscription; whereas in an outlying place at a distance from Carthage he discovered abundance of Punic remains by simply scratching the ground. He thought it would be similar in Jerusalem, and moreover the Romans used up old Jewish masonry in building their edifices. The best course the travellers employed by the Association could pursue would be to cultivate the good will of some semi-Fellahin tribe, who retained by tradition the names of ancient places mentioned in Exodus and Numbers, and set to work on the sites pointed out by them, which would probably be often some mound hidden in a wood.

Akin to the foregoing was a paper by Colonel Pelly, entitled "Notes on Arabia," which contained some few details not included in a former paper on his journey to the Wahabee capital, lately contributed to the Royal Geographical Society.

After an amusing anecdotical paper, "On City Life in Bokhara," by the Hungarian Dervish, Dr. Vámbéry, Sir Henry Rawlinson addressed the Section on the subject of the Russian Frontiers in Central Asia. He said that some few years ago the Russian boundaries extended from the northern shore of the Caspian Sea, by a long bend to the north, towards the limit of Chinese Tartary, and were separated on the south from the Khanats of Khiva, Bokhara, and Khokand—three countries which occupy the space between the Caspian and Chinese Tartary—by a wide region of Steppes, peopled by various tribes of Kirghises. A line of outposts, called the Orenburg and Siberian line, marked the course of this frontier. For many years their hold on the territory was but slight; and in 1847 they constructed three forts in order to strengthen it. They penetrated to the south of the Kirghis Steppe by sending a force in armed steamers up the Jaxartes river, which discharges itself into the Sea of Aral. The Steppe is traversed by few roads, but one of these is of great importance, extending from Orsk, north of the Aral, to the Jaxartes. It is traversible nearly throughout by wheeled carriages. By dint of gradual encroachments during the last few years, the Russians have occupied the whole of the Kirghis territory, and now their frontier extends along the Jaxartes to Fort Perofski, and thence through a part of the Khokand territory to the south of Lake Issyk-kul. They have thus advanced a thousand miles from north to south in the direction of British India, during the time that our own possessions have extended a thousand miles from south to north. The present distance between Peshawar, our real northern boundary, and the nearest point of the Russian frontier, had been ascertained lately by our agents, who had traversed the distance, to be about one thousand miles; but the distance from the territory of our tributary Kashmir to the same point, is only from four to five hundred miles.

Passing to Africa, the first subject which came before the Section was the discovery of the new Nilotic Lake, Albert Nyanza, by Mr. Samuel Baker. It was a great disappointment to the meeting to learn that the adventurous explorer himself had not arrived in England, as it was expected he would have been present to give a fuller account of his discovery. According to his last letter he intended to leave Khartum on the 21st of June, so that some obstacle has intervened to delay his homeward voyage. His letters, the contents of which have already been made public in 'The Times' newspaper, were read to the Section, and a discussion took place on the relative values of his discovery and those of the late Captain Speke. A large diagram of Africa was also exhibited, on which the new lake (copied from Mr. Baker's own sketch-map sent home from Khartum) was represented in the position assigned to it by its discoverer. It appeared a little larger than the Victoria Nyanza of Speke, and lay to the west of it, running in a north and south direction, but with a long bend at its southern extremity to the west. It covers the Luta Nzige as represented on Speke's map, and also part of the smaller lake *Rusisi*, which Speke had heard of from the natives of Karagwe, and which evidently forms part of the same vast inland sea. The speakers, Sir Roderick Murchison, Mr. F. Galton, and Sir Henry Rawlinson, all agreed that the discovery confirmed the accuracy of Speke's map in so far as concerned the discharge of the waters of the Nile after leaving the Victoria Nyanza into another vast lake, but the President reminded the meeting that the fact of the exit from the lake of the Nile (or the river which flowed past Gondokoro), still remained to be settled by direct observation.

The only other paper on Africa was one by Mr. Thomas Baines, the artist-traveller, descriptive of the Victoria Falls of the Zambesi, which he visited in 1862, spending several weeks on the spot, surveying the district, and sketching and photographing the scenery. A large series of oil-sketches besides diagrams, and a model of the Falls, all the work of the author, were exhibited, and conveyed a far clearer idea of this wonderful feature of Central Africa, than had hitherto been possible. The cataract is produced by the river, at a place where it is a mile-and-a-quarter broad, dropping into a deep narrow chasm which stretches entirely across its bed. From this transverse cleft the waters escape by a narrow passage into a long zigzag gorge, which continues for several days' journey down stream. The height of the cataract is about 400 feet, and the width of the chasm from 70 to 130 yards. From the bottom a dense cloud, or series of clouds, of spray arise to the height of about 1,200 feet, and the perennial shower of scintillating water-drops give rise in certain aspects to brilliant double rainbows.

Two papers were read by Colonel Pelly, on islands in the Indian Ocean, and off the east coast of Africa: one, the Seychelle group, and the other, the Comoros. The Seychelles, according to the author, are the summits of a group of granitic mountains surrounded by banks of coral, and consist of thirty islands, varying in size from a length of seventeen miles to islets containing only a few acres. The Comoros are larger islands, and four in number, one of which, Mayotte, is under French influence, they having a naval station on the islet Zaondzi, close to its shores. The Seychelles when discovered were destitute of inhabitants, but the Comoros were found to be peopled by an aboriginal race, of which scarcely any record remains, the islands having been for some centuries dominated by immigrant Arabs. Comoro proper, the largest and northernmost island of the group, is the least known, although the most remarkable in its physical features. Active volcanoes, 8,000 feet high, rise from its surface and pour forth streams of lava, which flood their flanks and rear or obliterate islands in the surrounding ocean. When the English consul, Mr. Sunley, recently visited the island, after an absence of four years, he found a lava reef, three quarters of a mile in length, jutting out near his old landing-place and perplexing his topography.

There was a short paper by Mr. Robert Swinhoe, entitled "Additional Notes on Formosa," and supplementary to a more elaborate paper, which he read at the Newcastle Meeting in 1863.

On Australia there was only one short paper, a sketch of the journey recently (in 1864) performed by Mr. Duncan McIntyre across the continent, from the Darling river to the Gulf of Carpentaria. This journey has excited great interest in Australia, owing to the discovery, by Mr. McIntyre, near the banks of the Flinders river, of supposed traces of Leichhardt. The traces consist of two trees marked with the letter L, and, from the age of the incision, believed to indicate a Leichhardtian camp; and of two old horses with half-effaced brands upon them, found straying in a region where no horses were ever left by any subsequent explorer. The geographical results of the journey were the discovery of a fine stretch of pastoral country,—smooth, undulating downs,—stretching from the stony desert of Sturt to the northern coast range, and of four new rivers north-west of Cooper's Creek. The journey from Cooper's Creek to the sea occupied only thirty-four days, a little more than half the time taken by either Burke or McKinlay. Mr. McIntyre's object was the discovery of a good route for stock to Northern Australia and the Gulf of Carpentaria, in which he appears to have succeeded. He found that no impediment exists to the construction of a carriage road or railway from the Darling river to the Gulf.

The question of North Polar Exploration was discussed in two papers having that title, one by Mr. C. R. Markham, and the other by Admiral Ommanney. Mr. Markham marshalled with great force the various arguments in favour of the Smith Sound plan, as proposed last winter by Captain Sherard Osborn, and already made known to the public. He quoted Sir Leopold McClintock as an advocate of this route, as the best for attaining the ends of a North Polar expedition, which are not simply to go to the Pole and back, but to explore, in the interests of various branches of science, the unknown area that surrounds the Pole. This could be done only by well-organized sledge parties, supported by two vessels stationed at a distance apart from each other. All the scientific societies of London which were invited by the Royal Geographical Society to co-operate with them in endeavouring to obtain the despatch of an expedition, were stated to have returned answers expressive of the great advantages to their respective sciences which would accrue. Mr. Markham adduced various known facts to prove that a sea voyage to the Pole, between Spitzbergen and Nova Zembla, as advocated by many, would be impracticable, and in this he was supported, in the discussion which followed the reading of the papers, by Mr. Alfred Newton, who had recently been in Spitzbergen, and stated that the Norwegian walrus-hunters had sighted land at various points between the two groups of islands, and had proved that they were connected besides by an impassable barrier of ice. The arguments in favour of the adoption of the Spitzbergen route by an English expedition had now lost much of their force, as a German expedition was being organized at the invitation of Dr. Petermann. A pioneer vessel despatched from Hamburg a few weeks ago had broken down soon after leaving port, but it was intended to renew the attempt next year. It behoved English geographers therefore, as the Spitzbergen route was now pre-occupied, to concentrate their endeavours on the obtaining of an expedition to penetrate *viâ* Smith Smith.

A short paper, "On Explorations in the Interior of Vancouver's Island," by Mr. Robert Brown, narrated the various journeys performed by an expedition despatched by the Vancouver's Island Exploration Committee, under the leadership of the author. Numerous rivers, lakes, chains of mountains, coal beds, and gold diggings were discovered, but the interior of the whole southern half of the island was found to contain very little land adapted for pasture or agriculture. Travelling southward, along the continent of America, the next paper was one by Dr. Cullen, "On the Isthmus of Panama and Interoceanic Ship and Canal Routes;" who also contributed an Ethnological paper, "On the Darien Indians." The Panama paper described all the various routes which had been proposed for a ship canal from ocean to ocean across the narrower parts of America, ending by advocating the Darien route, or that between Caledonia Harbour, on the side of the Atlantic, and the Gulf of San Miguel, on that of the Pacific. The last Geographical paper to be named was "On the Ascent of the River Purus," by Mr. William Chandless. This was stated by the President to be, in a geographical point of view, the most important one which had come before the Section; but owing to its length, and the shortness of the time for the Sectional business, only a few extracts could be read. He said, however, that it would form the subject of one of the evening meetings of the Geographical Society in the ensuing session. Mr. Chandless appears to be an English gentleman travelling for pleasure in South America, who, hearing of the failure of a Brazilian expedition to ascend this most important branch of the Amazons, in which, according to native report, there existed no impediment to navigation, resolved to attempt its exploration himself. Besides the importance of the Purus as a prospective channel of communication between the Atlantic (*viâ* the Amazons) and the rich southern provinces of Peru, east of the Andes, it has been for many years an object of great interest to geographers, owing to the mystery connected with its source. Its head waters have been presumed to be the river Madre de Dios, which flows from the Andes, in Southern Peru, and is supposed to be the seat of retirement of a large number of Inca Indians, who have effectively resisted all the attempts of white men to descend on its waters. Mr. Chandless ascended the Purus from its mouth a distance of 1,866 miles, and did not reach its source, but found it dwindled to a rivulet, lying 2° to the N.N.W. of the Madre de Dios. He met with tribes of Indians who had never had intercourse even with the semi-civilized tribes, and has constructed a complete map of the river from astronomical observations and compass bearings.

The Ethnological papers, as we have already hinted, were some of them of a Philological cast, some Anatomical, others Geological and Archæological, others even Historical, and the residue only purely Ethnological. The Philological series were:—1. "On the Origin of the Hungarians," by Dr. Vámbéry, an argumentive paper, proving, from a careful comparison of the grammatical structure of languages founded on the author's original observations, that the Hungarians are descendants of the Turco-Tartar nations dwelling in the western part of Central Asia; 2. "On Language and Ethnology," by the Rev. Mr. Farrar; and 3, "On Negro-European Dialects of the Negroes of Surinam and Curaçao," by Mr. E. B. Tylor. This last was an investigation of the curious, degraded idiom, compounded of various European languages, which has been developed amongst the isolated Negro populations of the countries mentioned; and from it the author deduced the conclusion that Philology was not a reliable guide in the affiliation of races. The papers of Anatomical aspect were, one "On the Influence of Civilization upon the Cerebral Development of the Different Races of Men," by Mr. R. Dunn; and another, "On certain Simious Skulls, with especial Reference to a Skull from Louth, in Ireland," by Mr. C. Carter Blake. The last-mentioned related to a modern skull, recently found at Louth, which bore a strong resemblance to the celebrated Neanderthal cranium; and it was shown that the contracted forehead, and other characters which had led some writers hastily to infer simious affinities in the Neanderthal skull, were due, as in the Irish specimen (exhibited to the meeting), to the premature closing of certain sutures. Of the Geological and Archæological papers in this Section, our limited space will not allow us to speak; besides, they come more properly under the Geological Section.

H. W. B.

NOTES AND CORRESPONDENCE.

On the Probable Conditions (Past and Present) of the Lunar Surface.

By T. Clifford Allbutt, M.A., M.B., Cantab.

I LATELY took up the number of your Journal, published in January last, and in it I find a letter from Mr. Nasmyth, in which he speculates on the vast antiquity of the lunar surface. By it I was reminded of a previous communication by Mr. Nasmyth on a like subject, which was accompanied by a most admirable lithograph of a portion of the lunar surface. As I read these remarks certain speculations, which I have long entertained, rose in my mind, and I now offer them to you for what they may be worth. Mr. Nasmyth says in his letter of January, that "the moon in all reasonable probability never possessed an atmosphere or water-envelope." He said, also, in his former communication (which I find in your number for July, 1864) that the moon is not necessarily a "useless waste of extinct volcanoes," although it be "unfitted for animal or vegetable existence as known to us," &c. &c. In these and in many similar places Mr. Nasmyth does but speak as all competent astronomers speak of the moon, as being now a hideous waste, airless, waterless, and lifeless; and as having probably been so always. Now, sir, I cannot but take a view, which to some degree differs from this. As regards the present state of the moon, I am in full agreement with Mr. Nasmyth and other admirable observers whom I trust far better than I trust myself. I differ with them in regard of their inference as to the past states of the moon. I may be allowed to quote from Mr. Nasmyth's first paper, the following line, "particles, originally existing in a diffused condition, were by the action of gravitation made to coalesce and so to form a planet." It will be seen on reference that he thus speaks in explanation of certain volcanic phenomena common to the moon and to our own planet; and that he speculates on their common origin and similar development. The consequents which we find in the moon being so far almost identical with those which we find in the earth, we are justified in expecting that the antecedents were also identical, or nearly so.

I am glad to have this common starting point, and these common results, from which I may ask Mr. Nasmyth to pass to a consideration of transition states.

Now, sir, no discoveries have interested us more than those by which we have learned that the constituent elements of our own planet correspond in great measure, if not thoroughly, with those of other heavenly bodies. These discoveries justify a presumption that the moon, which as a mass of matter lies adjacent to us (and has even by some been supposed to have been ejected or detached from our own planetary mass at some early period of consolidation), consists of elements the same, or nearly the same, as those of which the earth consists. We should then further presume that, if subject to like conditions, the mass of the moon would also tend to pass through stages of existence corresponding to those of the earth. Some of those conditions, however, are widely different, as, for instance, the relation of volume to superficies, the power of gravitation, and some others. Still these differences are such as to affect the periods of the moon's development, rather in degree than in kind; in time, for instance, or in intensity. May we not therefore reasonably suppose, when the mass of the moon had only cooled down to the state in which the earth now is, that at such period of her existence the relative densities of the various component elements, one with another, might resemble those which we now see on the earth; and that certain of them might then exist in a fluid or gaseous state, and form such watery and atmospheric envelopes as we possess? Owing to the small mass of the moon, this stage would be of much shorter duration than with us, but are we not bound to assume, in default of proof to the contrary, that it has been traversed? Our paltry experiments can give us but a feeble conception of the results of the intense cold of the now shrunken and burnt-out mass; but it is quite in analogy with them to suppose that those limits may be passed within which elements can exist as fluids or gases. It is indeed, *à priori*, unlikely that the moon should now possess such envelopes. We must remember that the fluid and gaseous states are but states of relative densities, and do not inhere in the nature or constitution of any particular element.

I would now ask permission to pursue these speculations a step farther, to carry them on from the physical to the possible vital endowments of the moon. The present want of life upon the moon is even more certain than the want of air and water: but must this have always been so? To repeat my former suggestions, I may say that the mass of the moon must in cooling have passed through a temperature more or less fitted for certain forms of life. Its constituent elements, moreover, being in all likelihood similar to our own, we may well conceive that they would develop into similar combinations; that is, into combinations fitted for the support of life.

If such combinations existed, we have no reason to conclude that the gift of life was withholden from the moon; or if life be looked upon simply as a product of planetary change, we have every reason to suppose that it would find its place in the weaving together of the moon's processes. I cannot then help looking upon the moon, now cold and dead, as having once passed through the bloom of life, that bloom which will one day pass away from this beautiful earth when all we who dwell in it are beyond its gates. On the other hand, I would not have it supposed that I overlook the many difficulties which oppose me, such, for instance, as the peculiar aspects which the moon bears to the sun.

Nor do I ask that the moon may be regarded with certainty as a depopulated world; I only ask whether the probabilities from analogy are not strong enough to make us pause before we speak unhesitatingly of the moon as of a body blasted from its birth. It may be urged against me that my speculations are too fanciful, and that mere dreaming of possible pasts is no gain to science. I should reply that I did not initiate the dreaming process. It is not for me now to assert, though it may well be asserted, that any speculation on the past history of heavenly bodies is full of gain to science. All I have now to do is to offer one inference in place of another, to show that in this argument from the known to the unknown, two solutions at least are possible, and to show if I can that one is more probable than the other. With my apology for intruding so far upon your space, I remain, sir, yours faithfully,

T. CLIFFORD ALLBUTT,
Physician to the Leeds Infirmary.

Leeds, Aug. 28, 1865.

On Petroleum Springs in the Eastern Crimea, and on the Shores of the Sea of Azof. By Professor D. T. Ansted, M.A., F.R.S.

AMONG the many sources of supply that the demand for illuminating and lubricating oils has brought into notice, there are some that have been known to half-savage races from time immemorial, and actually used for similar purposes to those for which they are now applied. Some of these, though hitherto neglected, are both abundant and important. The shores of the Caspian Sea where the perpetual fires of Baku have been objects of pagan worship for at least two thousand years, and some islands of the Caspian where naphtha springs yield a yet larger supply, are well known instances. These places now supply petroleum and oils, such as we call "paraffin oil," to a great part of Asia Minor and the south of Russia. Conveyed by water to Astrakhan, and thence by the Volga, they reach Nijni Novgorod and are carried to Moscow. Conveyed by land across Georgia, the prepared oils are used almost to the exclusion of every other kind of illuminating material at Teflis, now a large and important city, and there seems no limit to the quantity that could be used even at a very high price if the supply were sufficiently large. At various places, as near Teflis itself, there are petroleum springs, but they are not available, as the rock oil cannot be used without distilling, and there is no apparatus for that purpose. Still farther west, at the extremity of the great chain of the Caucasus, there is a large and remarkable district, more than a hundred miles from east to west, commencing with the delta of the Kuban and the peninsula of Taman, and ending in the Putrid Sea, remarkable throughout for those curious phenomena known as "mud volcanoes" or "salses,"—some in an active state, and some recently extinct,—for springs of mineral water loaded with sulphur, sulphuretted hydrogen, nitrogen, and other gases, and for wells of petroleum, either with or without water.

These latter are far too important in the present state of the oil market to be matters of indifference. Wherever petroleum can be obtained of tolerably good quality, and in tolerable abundance, not too far from a place of shipment, it will of course attract attention. Oils from certain deposits near Kertch, in the eastern part of the Crimea, have already been shipped to England, although the local demand will probably prevent any great exportation, even if the quantity raised should be very much larger than it has hitherto been.

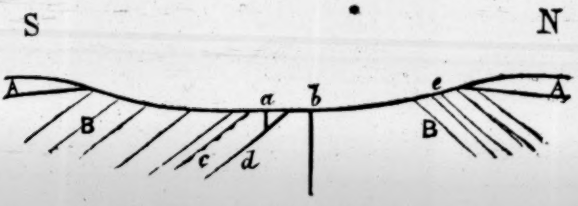
The Crimea is by no means inaccessible, and even the extreme ports of the sea of Azof, Berdiansk, and Taganrog are well known to all interested in the bringing of corn from the vast steppes of Russia to the English market. The sea of Azof is approached by the somewhat shallow straits of Kertch, the ancient Cimmerian Bosphorus, a passage between the peninsula of Kertch, a long straggling tract of land terminating the Crimea to the east, and the peninsula of Taman, an equally long and much more straggling land projecting from the western extremity of the great Caucasian chain, and containing the low swampy delta of the river Kuban, which is the main stream conveying the water falling on the northern watershed of the Caucasus. The upper part of the Black Sea where it enters the sea of Azof is shallow, and the sea of Azof itself has nowhere more than a few fathoms of depth. Older tertiary rocks covered by tertiaries of newer date are here the only rocks to be seen, but they are often much altered, though the country is either a dead level, or consists of rolling ground, formed by the removal of beds of hard limestone, by denudation probably after fracture, and by the scooping out of wide, shallow valleys originally formed by faults and small elevation axes. The only exception to this state of things, is when conical hills, detached or grouped, rise up out of the plains and present the curious appearance of mud more or less liquid, welling slowly from an orifice in the ground, forming hillocks by the material erupted, and allowing of a slow escape of certain gases, of which nitrogen and sulphuretted hydrogen seem to be the most frequent.

In a visit I have recently paid to this part of the world, I have been greatly interested by the mode in which these mud volcanoes are connected with petroleum wells, and by the essential difference that seems to exist between the conditions under which petroleum is found in the United States and Canada, and those met with in the East. In the former, as is well known, large quantities of oil are tapped, as it were, in the interior of the earth, where stores of this mineral exist under heavy pressure, and where it is kept down by beds of limestone or sandstone more or less nearly horizontal. Once tapped, the pressure causes the oil to rise up to, or even far above, the surface, just as water rises in an Artesian well. The petroleum obtained in the Crimea differs greatly in the circumstances of getting it, owing to the total difference of the geological conditions of the rocks. In its general nature it is, however, quite similar. The oil is found only at the bottoms of wells, into which it rather oozes than pours from the natural stores in the interior of the earth, whatever and wherever they may be. The Tatars—the old inhabitants of the Crimea—have sunk innumerable small wells, of which the indications may still be traced, and from the position of these may be obtained an idea of the nature of the sources of supply. The wells thus indicated are almost without exception in narrow bands, extending often, but not always, along the axis of east and west valleys, midway between the limestone cappings to the north and south.

The petroleum springs of the Crimea are entirely confined to the eastern part of that land, and almost entirely to the peninsula of Kertch. There are several very well-marked belts of country in which wells sunk a few yards into the soil yield more or less naphtha of very fair quality, and in most cases these have long been known and worked, though only to a very small extent. During the early part of spring, and also in the early part of summer, the position of the petroleum is considered to be marked by lines of different colour to the rest of the soil. In the early part of the spring these lines are greener, and in the early summer they are yellower than the rest of the land. This, if it can really be depended on as a useful guide in the discovery of fresh sources of supply, must be due to the influence of the oil on the soil where the naphtha crops out. The whole belt of land containing mineral oil is considerable, reaching across from the sea of Azof to the Black Sea as far as Arabat and Kaffa, and it may extend even farther to the west in the steppes. Beyond Arabat there are, at any rate, numerous springs of petroleum, as well as of sulphuretted hydrogen, in the Putrid Sea, whose name is derived from the oppressive smell of rotten eggs that pervades the whole atmosphere in this curious expanse of saline water. It is probable that the supply of mineral oil is both very large and very near the surface in many parts of the country where the geological conditions are favourable.

While examining the most productive and most remarkable of the naphtha-yielding springs, I was struck with their marked relation to the structure of the rocks, the existence of faults and anticlinal axes, and the numerous and systematic groups of mud volcanoes and salt lakes that meet one at every turn in this curious country. It must not be supposed, however, that all the innumerable conical hills and hillocks seen in the Eastern Crimea are of volcanic origin. It is as certain that a great many are of purely artificial origin, as that others are natural, and built up entirely of mud. Nowhere, for instance, are tumuli so common, nowhere are old cairns more systematic, and nowhere have real hills been more curiously encased and cut into definite shapes by ancient peoples who once inhabited these lands. But nowhere, also, is it easier to recognize the little cone derived from the slow outpouring of soft mud, and distinguish the natural crater of an extinct volcano, though it may now be a pool of rain water.

FIG. 1.—*Section across the Valley of Beshevli.*



A. Limestones nearly horizontal.
B. Shaley clays dipping 45°, but in opposite directions on the two sides of the valley.
a. Pits to the oil-bearing bed *d.*
b. Boring down 500 feet in clays.
c. Bed of iron oxide.
d. Oil-bearing bed.
Horizontal Scale—One inch to a mile.

As a general rule, the petroleum wells are at some little distance from the mud volcanoes and the salt lakes. One of the most remarkable groups is that of Beshevli, about fifteen miles west of Kertch. The valley in which the springs are found is of considerable length, running east and west. A section across the valley at a place where several natural sections show the structure is given in the above diagram. A well-defined band of nodular clay ironstone (*c*), some inches thick, is seen in a small ravine, dipping 56° SSE. About 60 yards to the north, at *b*, is a rotten bluish clay, cropping out at the surface, loaded with naphtha. Into this clay a hole dug two feet rapidly becomes filled with naphtha to a depth of some inches, and on reaching this clay, by wells dug from 20 to 50 feet, very uniform and important supplies are produced. Some of this naphtha is of a deep-green colour, thin and transparent.

The oil-bed at Beshevli crops out along a line more than a mile in length in the valley of the same name, and probably extends farther, in both directions, than it has yet been proved. Numerous old wells, dug by the Tatars, are to be found along the line, and I counted upwards of twenty modern sinkings, varying from a few feet to about 50 feet, all of which had been more or less successful. Many others, sunk at a little distance from the line thus marked, and to a much greater depth, were failures. One in the lowest part of the valley (*b*), bored 500 feet to the north, a little beyond the crop, yielded no trace. About half a mile farther to the north there were springs so loaded with sulphur, as to coat the water with a film to a great distance, and cover all the rocks in the neighbourhood. At the place (*e*) where these springs come out, limestone overlies the rotten clays, shales, and ironstones unconformably. The rock itself that yields the sulphur, dips heavily to the north, and thus shows the presence of a fault or anticlinal axis in the valley, between *a* and *e*. There was everywhere proof that near the place where the belt of naphtha wells is traceable, there was a change of dip marking local disturbance and displacement of the strata.

Although the petroleum springs of the valley of Beshevli have not actually been traced more than about 2,000 yards from east to west, there are, as I have already mentioned, good indications of the continuance of the same condition of the rocks for some distance. The valley, however, terminates some distance beyond the last well, and the limestone conceals the oil-bearing beds for another two miles, after which there are strong sulphur springs in a cross valley between the valley of Beshevli and the coast range of limestone. Beyond this are the waters of the sea of Azof.

Another remarkable and interesting petroleum spring is within a few miles of the town of Kertch, to the south-west; and here also the geological conditions are both curious and instructive. In a valley running westwards into the country, but not opening from the sea, enclosed between hills capped with limestone, one of which is very celebrated in ancient history as the tomb of Mithridates, there is seen a conical hill with a large crater open on the side towards the north, and on approaching the hill the opening is seen to resemble another valley, and to contain other much smaller cones of various size, some extremely perfect, and one perhaps 50 yards in circumference at the base. Close to the base of this cone, to the west, a well has been sunk in rotten clays and shales, sandstones, and nodular masses of iron, all dipping about 70° to north. In this well oil was reached at 17 feet, at a bed overlying the nodular ironstone. From 17 feet to 60 feet there was always some oil, and at 60 feet a band of sandstone was cut through. This rock was saturated with bitumen, and below it petroleum came into the well with great rapidity. Three feet lower the ground was so soft and tough as to rise up and render any further sinking impossible with the means at hand. A bore was then put down, and the oil stood at 6½ feet above the bottom of the bore at the time of my visit, and was replaced very rapidly when removed. The naphtha raised was of excellent quality, and remarkably clear and pure. There was no water whatever in the well or boring.

The ground where this well was sunk is about 100 feet above the level of the Black Sea, measured by a good mountain aneroid. About 50 yards to the south is an active mud volcano, and several small cones resulting from the eruption of mud are to be seen in an east and west line from this point. Some of them are at a considerable distance, and besides them sulphur springs appear both to the east and south. A very few yards beyond the line of the mud volcanoes to the south several borings have been made, but no trace of petroleum has been found.

Other borings nearer the well have shown a trace of oil, and a strong bituminous odour was found to characterize all the strata, but no sinkings have been successful that have not reached the sandstone. There can be no doubt that the source of supply of oil in this case is limited to the line of strike of a certain stratum, and it is more than probable that here, as at Beshevli, there is a reversion of strata and an anticlinal axis close by. At this point, however, I was unable to obtain proof of the axis by independent observation, for though the limestone capping the shales dips to the south, the shales are quite independent of these limestones. The existence of the line of mud volcanoes is however sufficient to justify the assumption that there is a fault or fissure communicating with the seat of chemical changes and operations in the interior of the earth.

A remarkable instance of petroleum springs is to be found on the shores of a salt lake some ten miles to the south of Kertch, close to the line of coast. The lake is large but shallow, and its level is a few feet below that of the Black Sea. It is called 'Tchongolek.' It is separated from the sea by a low bank of shelly sand a few feet above the highest level of the Black Sea, so that there is at no time free communication between the two waters, and the level of the lake is permanently below that of the adjacent open sea by at least five feet. A cliff of shelly calcareous sandstone, of considerable hardness and from thirty to forty feet high, containing exclusively the shells of common species still inhabiting the Black Sea, exists on the north side of this lake, and is of some extent, since a road is worn or cut through it by which the lake is approached. The lake is very salt, and its waters are largely evaporated for the manufacture of salt for local use. It is evident that the lake has been much reduced in this way, for there is a level tract of nearly a quarter of a mile of mud between the banks and low cliffs that enclose it and the present water. The lake is pear-shaped, about two miles across in most parts, but there is a kind of inlet opposite the sea running another two miles into the country, and, perhaps, sometimes receiving a small amount of local drainage. On the south side of this lake (at *a* in the chart, Fig. 2) one is struck by the conical form of a part of the shore, and the appearance of a large semicircular space like an amphitheatre 300 yards across, scooped out and open towards the east. This is a hill of marly and shelly limestone, with gypsum, soft when weathered but very hard in the inside. Towards the east and north these rocks form nearly vertical cliffs 60 feet high, the rock pitching more than 45° to the north on the north side, and more to the west on the east side.

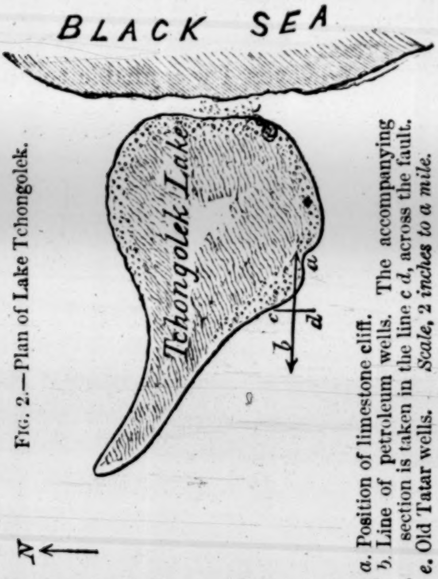
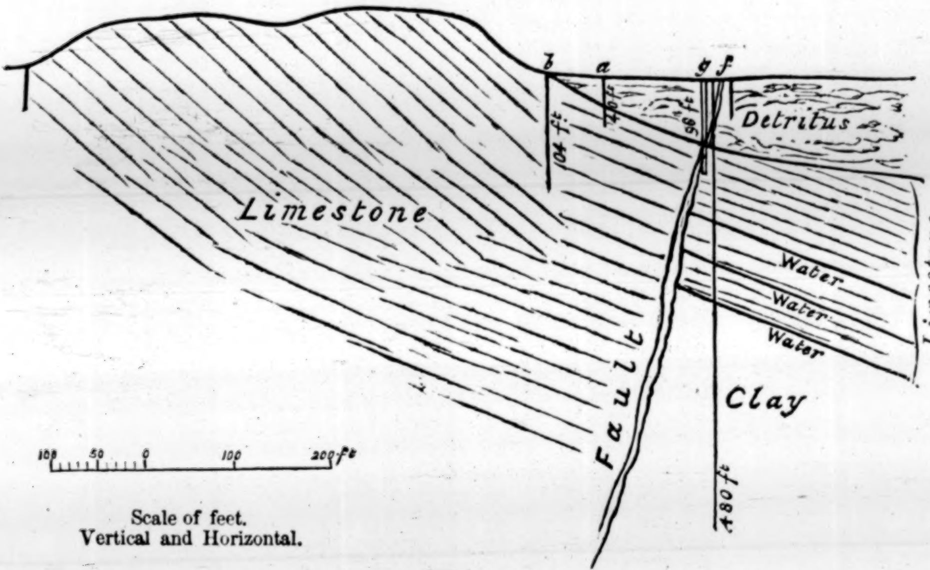


Fig. 2.—Plan of Lake Tchongolek.

a. Position of limestone cliff. *b.* Line of petroleum wells. The accompanying section is taken in the line *c d*, across the fault. *e.* Old Tatar wells. *Scale, 2 inches to a mile.*

Just beyond the foot of these limestone cliffs to the north there is a line of petroleum springs. These are made known by the bubbling up of gas, accompanied by mineral oil, through the mud and water of the lake. They are also clearly indicated on the banks of the lake by a number of old Tatar wells, which range nearly east and west. Close to some of these old wells, and in various other positions, wells have been sunk and borings made in modern times. These vary in depth from 30 to nearly 500 feet. Some are through small depths of limestone into clay, others through surface accumulations to limestone, others through limestone only. Only some are successful, and the general result is that the petroleum must rise through or very near to a fault of considerable magnitude, which has thrown up the limestone to the north, on which side they have been denuded and their thickness much diminished. Where the fault is cut is apparently the place where most petroleum issues, and where after this the limestone is pierced, as in one of the wells, the supply of oil is diminished, and it comes up mixed with a good deal of water. The section in the next page will illustrate the nature of the case, and is proved by a number of sinkings, of all of which I have the particulars. Borings on either side of the line of fault have failed to reach anything more than the merest indications of naphtha. In this case there cannot be a doubt that the petroleum issues from a fault or line of fracture, but there is no mud volcano in the neighbourhood, and no volcanic indication of other kinds. The rocks around are chiefly limestones, but with some of them gypsum is largely intermixed. The clays reached in the deep bore were apparently of the same nature as

FIG. 3.—*Section across part of the Shore of Lake Tchongolek.*



Scale of feet.
Vertical and Horizontal.

those that generally yield petroleum in the district. The dip of the clays there are no means of determining.

On a continuance of the line of this fault as marked by petroleum wells, there are other wells at various points to the west to a distance of about two miles. The waters of the lake also show bubbles of gas with petroleum rising at some distance from the shore, far beyond the last well to the east.

There are at least half-a-dozen other distinct localities, within 30 miles of Kertch, in which naphtha has been obtained by the Tatars in old times, as shown by their lines of wells, and also by modern sinkings, none of them very deep. All are characterized in the same manner. All occur in valleys, and the strata through which the petroleum rises are always highly inclined and generally much disturbed. They are always the marls and clays of the lower series, over which the limestones with few exceptions lie unconformably. The direction of the belts of ground yielding petroleum, of the principal lines of elevation of the district, and of the lines of direction of the mud volcanoes, are all approximately the same, and there are springs of mineral water that appear to have a similar bearing.

I think there can be no doubt that throughout the whole petroleum district, extending from the eastern shores of the Caspian Sea to the Carpathians, a distance of more than fifteen hundred miles from east to west, there must be similar causes at work to produce effects so identical as those obseved. At intervals, which, it is true, are of considerable length, but always in rocks of the same kind, and of the same geological age, always, that is, in clays and marl of middle or older tertiary date, there are certain bands or belts of highly-inclined and fractured strata, through which mineral waters, mud, or petroleum occasionally issue. These are all strictly connected with the last great elevations to which the lands of the pre- and post-glacial epochs are due. All those lands, whether actually then above the water or only shoals rising slowly to form the vast steppes and plains of Asia and Europe, are due to the action of disturbing forces, which, in other ways and other places, have poured forth floods of molten rock upon the surface, or beneath the sea have thrown into the air gases, smoke, and fine dust to cover and influence the earth, and have shaken, by systematic convulsions, the part of the crust of the earth too tense or too well defended by overlying masses to be broken asunder. Mountain chains have been lifted up both to the north and south of the great axis of elevation, and within open spaces formed in the rocks there has been at certain points a considerable amount of chemical action, resulting in the eruptions from volcanoes and the issue of mineral waters.

It will always be a question of great interest whence the carbon was obtained for the manufacture of those hydrocarbons, of which petroleum is one, and those gaseous emanations, in which carbon forms an important part. There can be no doubt that in the great majority of cases in America and Canada, the carbon has previously been accumulated by vegetable or animal organisms, buried under favourable circumstances, and retained during successive ages, until an outlet is found whence they may once more come to the surface. It is, however, equally certain that such accumulations as the great pitch lake of Trinidad, and some others less extensive, cannot be traced to have a history of this kind, and thus the question remains open. It is a matter of some interest that lignites consisting of vegetable matter in a state of only partial metamorphosis, have been found in the tertiaries on the flanks of the Caucasus, not far from Anapa, and also in the Carpathians. Similar accumulations, of very large proportions, are well known in other parts of the great expanse of middle tertiaries east of the Alps. It remains, therefore, possible, though there is as yet no proof obtainable on the subject, that the petroleum wells of the Crimea are connected with old accumulations of vegetable carbon. The fact is worth recording, that it may be proved or disproved in the particular case.

Speaking chiefly of the oil wells and oil supplies, I have said little of the mud volcanoes and the salt lakes. Both are peculiar, and in the highest degree interesting in reference to the oil supply. The vicinity of the mud volcanoes to petroleum springs, is very marked in one of the cases I have described, and the presence of numerous small wells in the line of mud volcanoes, beginning with those of Taman and crossing the northern end of the peninsula of Kertch, is suggestive. Petroleum is also found oozing through the earth and rising to the surface of the water in the neighbourhood of Tchongolek. Sulphur springs, of which the water is so loaded with sulphur as to cover with a film every surface over which it runs, and leave a thick scum on the water as it runs away into the valleys, are by no means rare within a few hundred yards of well-marked lines and belts of old wells. Here, again, there is an evident tendency to volcanic origin in the whole of the phenomena. As it is well known that the volcanic fires have only recently become extinct in all this neighbourhood, and as volcanic rock of modern date is extremely abundant at some little distance to the south of the central part of the Caucasus, covering with only occasional small exceptions a lenticular space six hundred miles in length and two hundred miles wide in the widest part, it need not excite astonishment that there should be important incidental results of this energy. The volcanic centres must be deep-seated, compared at least with any ordinary thicknesses of strata, but the work of nature in this part of the world has been on a very large scale in recent times and chiefly in the work of reconstruction, lifting up the wide tracts of sea bottom into plains and even mountains, at a rate that may be slow enough in one sense, but which has been much more rapid than the effect of weather and water in wearing away by denudation all evidence of the work done. Thus it is, that the appearance and nature of the rocks, and the nature of the scenery in Eastern Europe and Western Asia are eminently characteristic of the most recent of the operations that have been continually going on, but which are masked and lost in Western Europe, where there has been far more denudation than deposit, and where the tertiary rocks are comparatively unimportant.

As a general conclusion to these remarks, on the naphtha springs of the Crimea, I would point out that their value and importance are to be estimated only when they are viewed as parts of a whole, and as among the results of volcanic action on a very large scale in very recent times. I think no one can study the evidence I have here brought forward,—I am sure no one could examine the phenomena on the spot,—without being struck with the mutual relation of the oil springs, the mud volcanoes, the sulphur springs, and the general form of the country. The same may be said with regard to the whole expanse of volcanic country from the south shore of the Caspian, to midway along the south coast of the Black Sea. It is only by considering the phenomena as a whole, that they can in any way be understood, and thus I have ventured to generalize and connect rather than to give a mere detailed account of the particular points examined.

D. T. Ansted.

Athenæum Club, London,
August, 1865.

The Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot. (Correction.)

I should feel much obliged if you would kindly, in your next 'Quarterly Journal,' correct a rather serious error which has crept into the appendix to the 'Report on the Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot,' by Mr. King and myself, and which has been perpetuated in the very complimentary review given in your April number.

The number of tons of charcoal required to smelt a ton of the magnetic iron is 3¼, and *not* 13¼, as stated in the Report (p. 161) and copied into the review (p. 343).

R. Bruce Foot,
Geological Survey of India.

Yercand, Madras,
July 11, 1865.

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